*Natural Sciences 360*
*Legacy of Life*
*Lecture 13*
*Dr. Stuart S. Sumida*

# Living Amphibians – the Environmental Monitors

# REPTILES AND THEIR RELATIVES

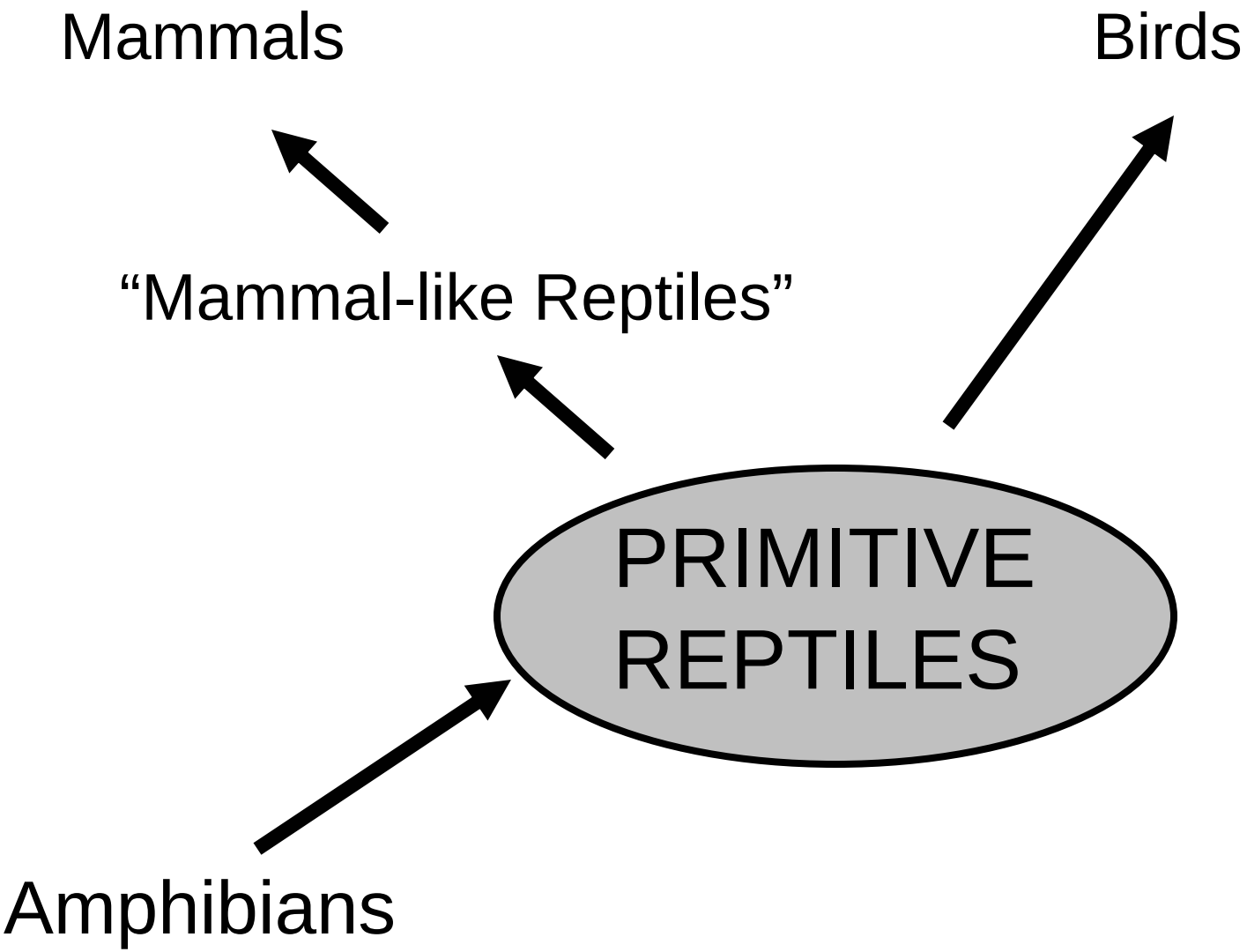
Living Frogs and Salamanders (Batrachia) – the environmental monitors.

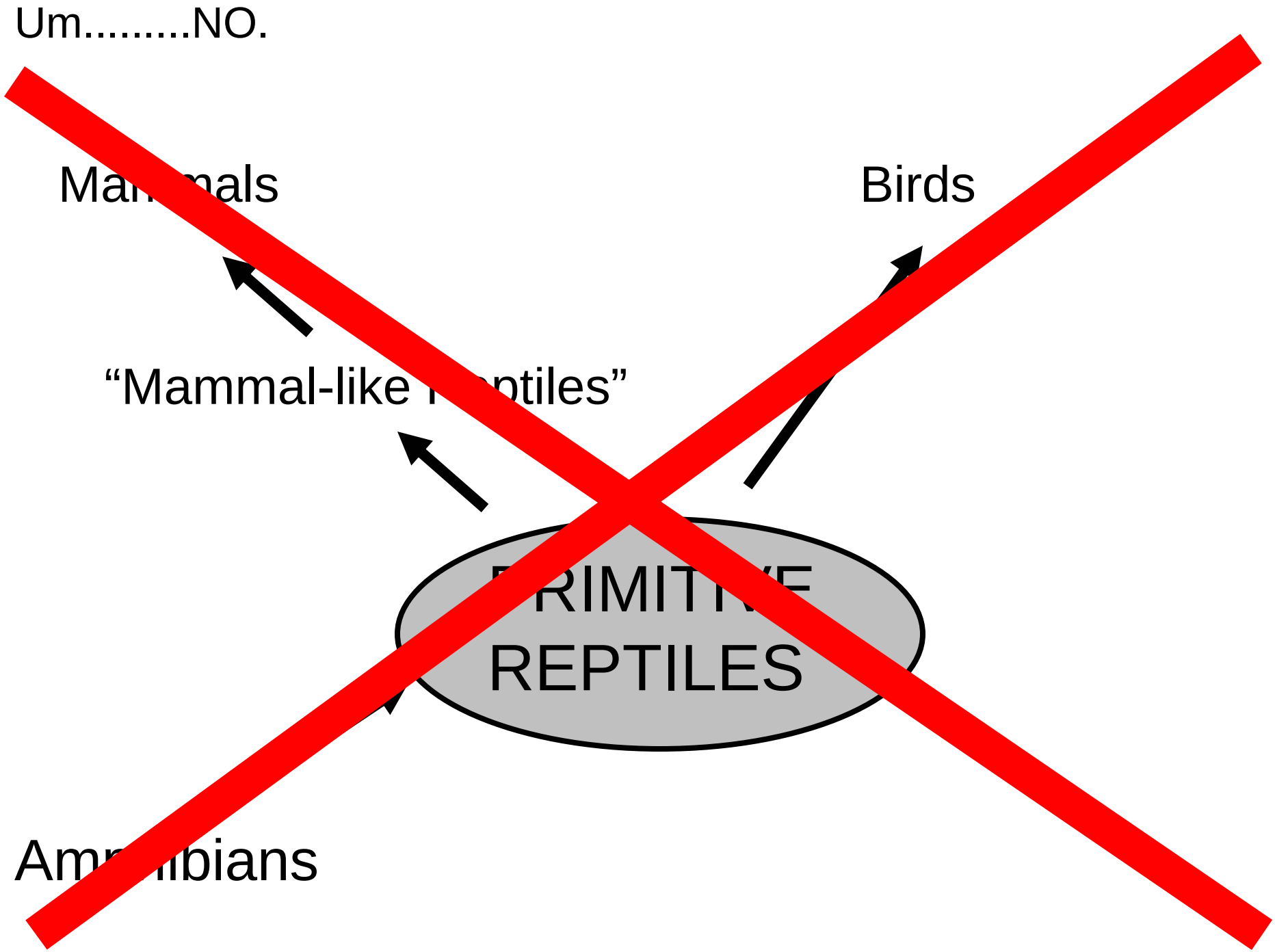
Possible causes of amphibian declines include:

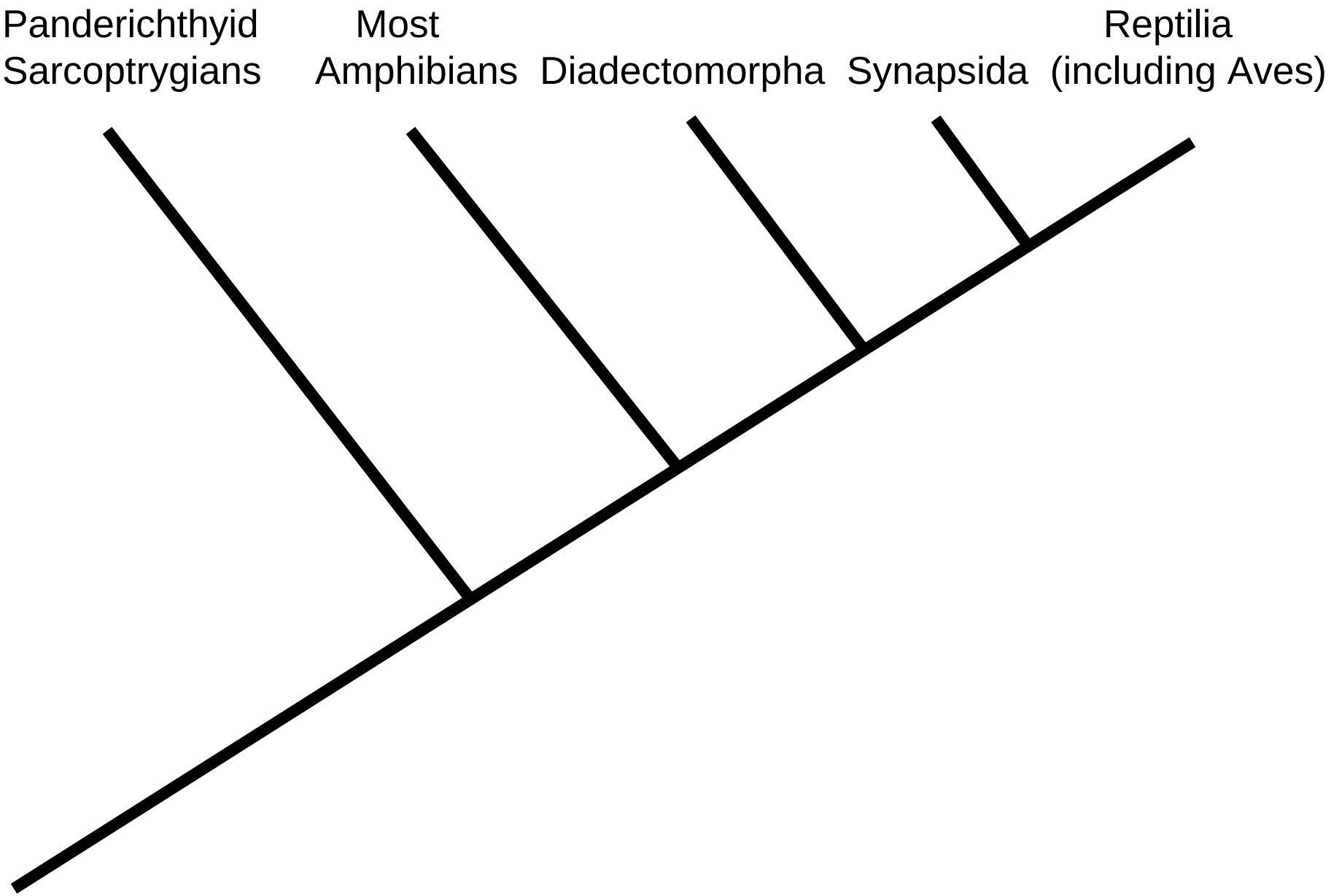
- Changes in climate - acid rain, ultraviolet radiation, drought, ozone layer depletion, etc.
- Loss of wetlands
- Invasive predators (such as trout and bullfrogs)
- Disease (bacteria, viruses, fungus) or parasites
- Pollution - pesticides, fertilizers, heavy metals, etc.

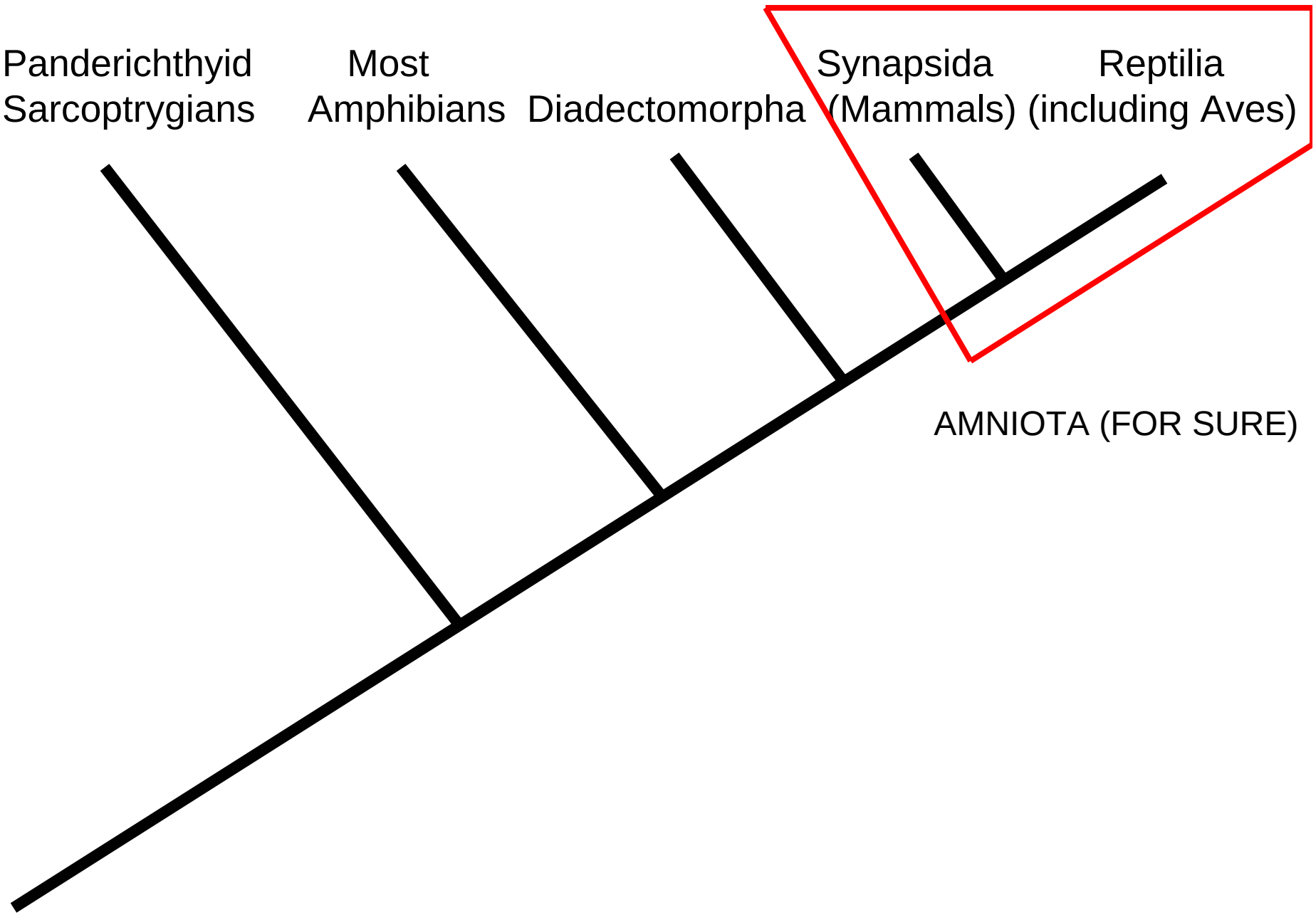
New Discovery!  A LUNGLESS FROG!

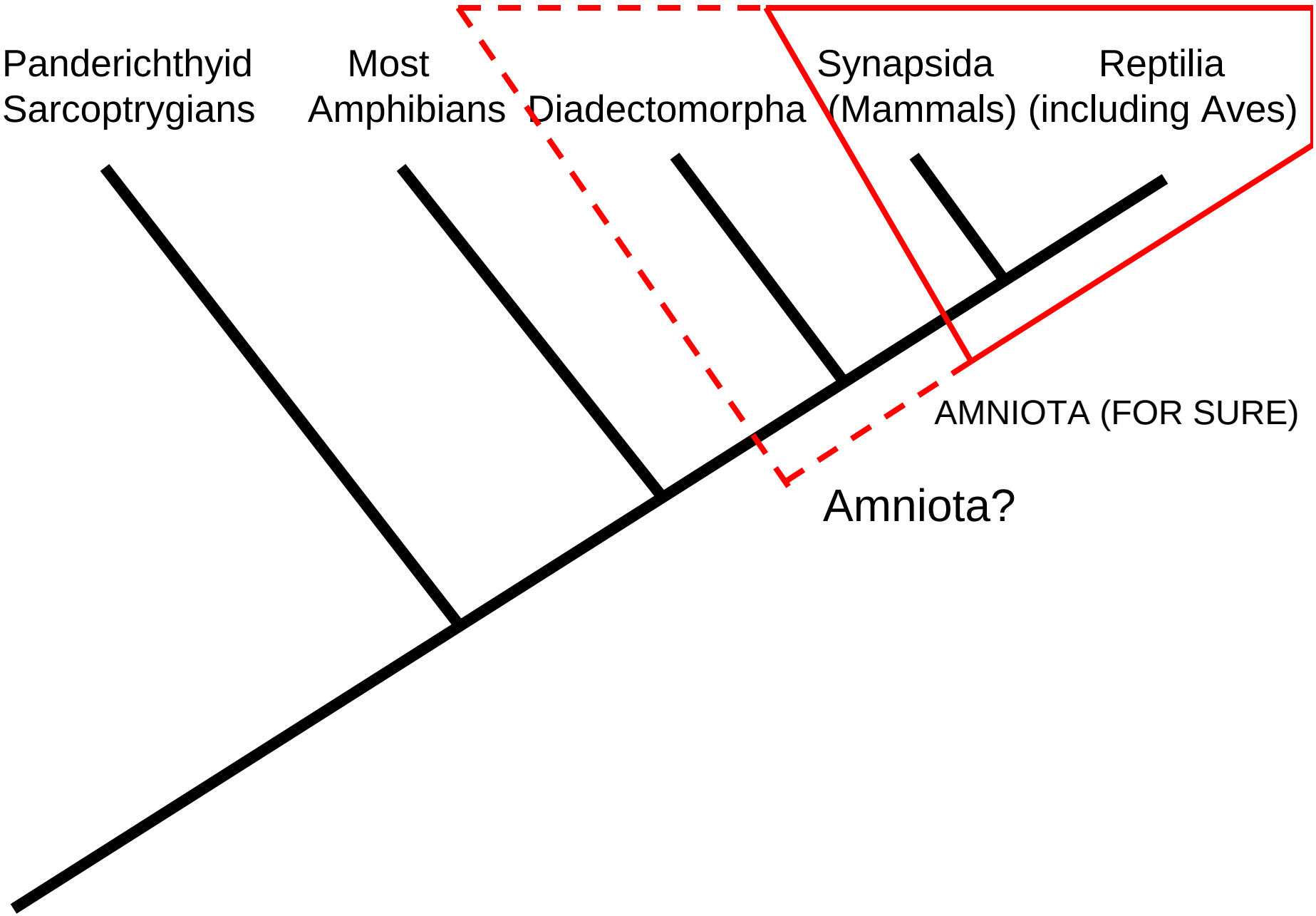
What we used to think...

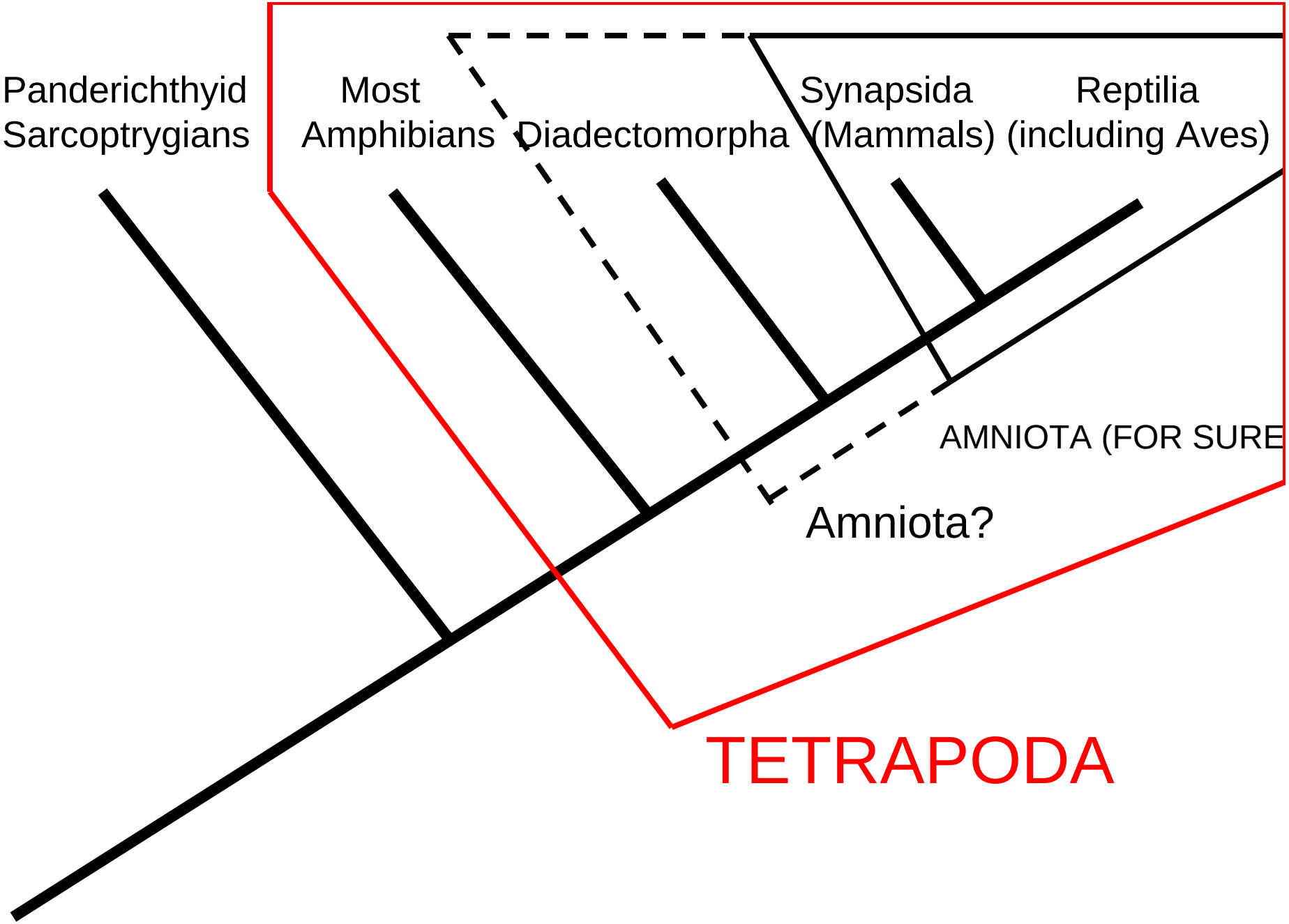


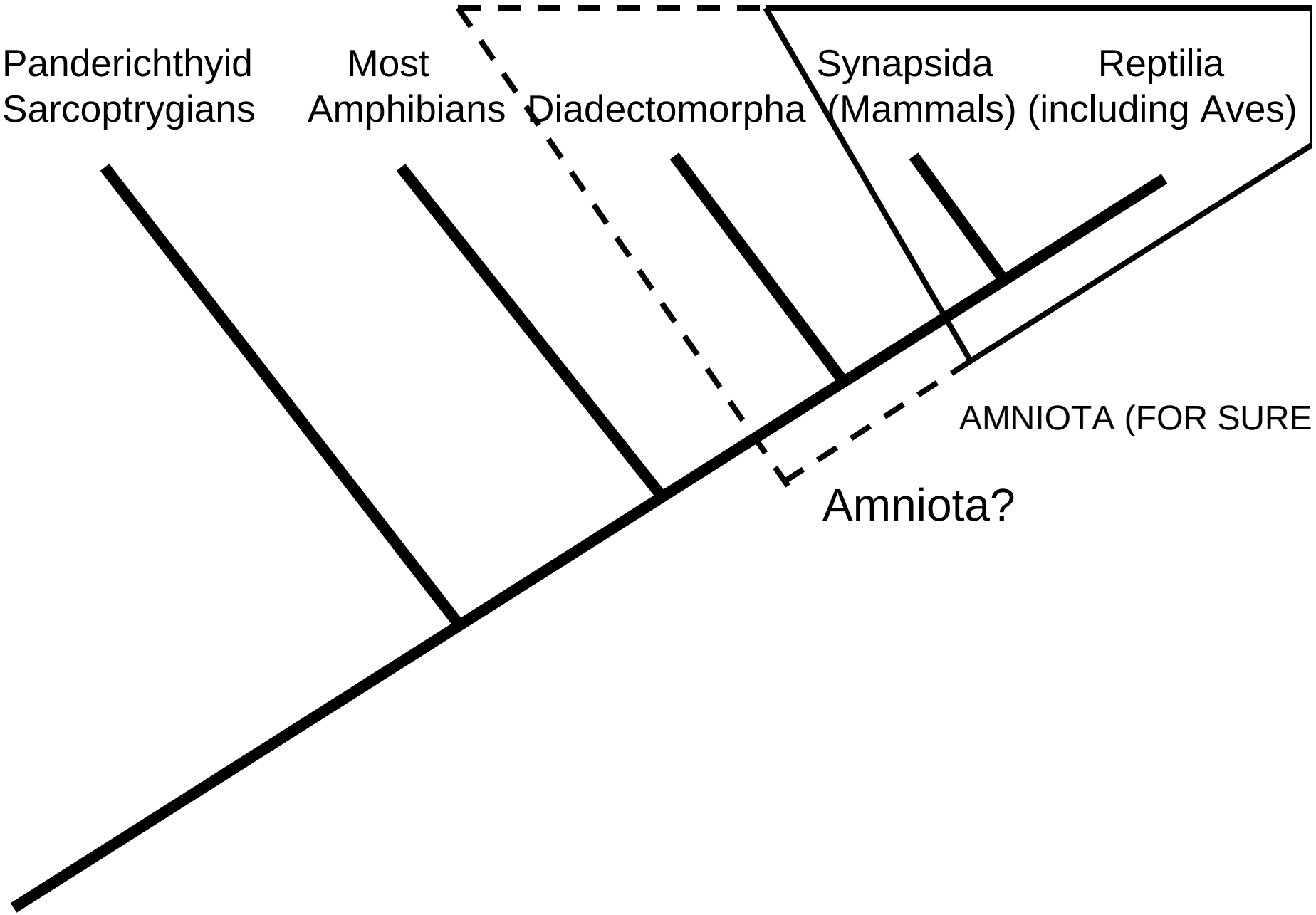

Um.....NO.
Mammals
Birds
“Mammal-like Reptiles”
PRIMITIVE REPTILES
Amphibians


Panderichthyid Sarcoptrygians
Most Amphibians
Diadectomorpha
Synapsida
Reptilia (including Aves)


Panderichthyid Sarcoptrygians
Most Amphibians
Diadectomorpha
Synapsida (Mammals)
Reptilia (including Aves)
AMNIOTA (FOR SURE)

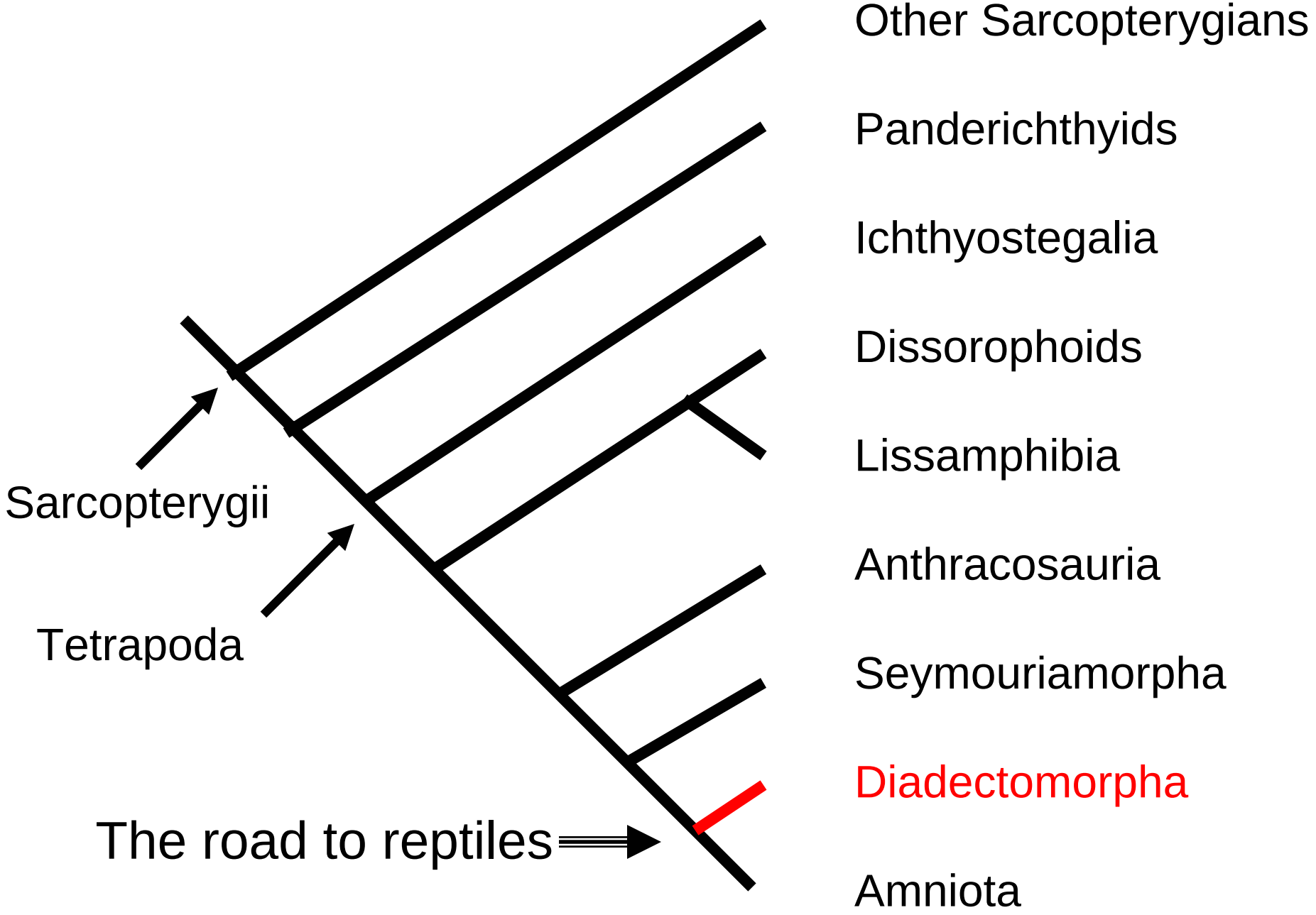

Panderichthyid Sarcoptrygians
Most Amphibians
Diadectomorpha
Synapsida (Mammals)
Reptilia (including Aves)
AMNIOTA (FOR SURE)
Amniota?

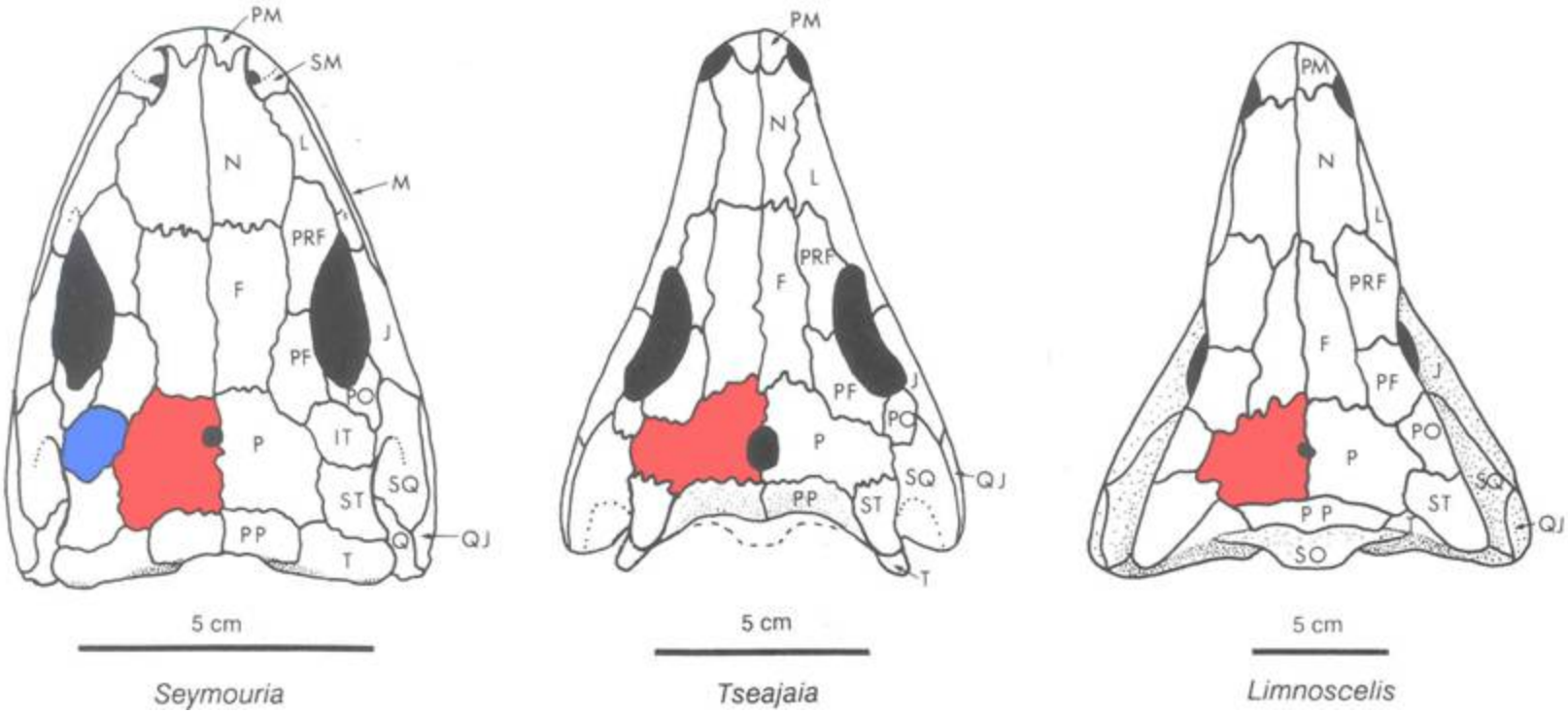

Panderichthyid Sarcoptrygians
Most Amphibians
Diadectomorpha
Synapsida (Mammals)
Reptilia (including Aves)
AMNIOTA (FOR SURE
Amniota?
TETRAPODA


Panderichthyid Sarcoptrygians
Most Amphibians
Diadectomorpha
Synapsida (Mammals)
Reptilia (including Aves)
AMNIOTA (FOR SURE
Amniota?

Amniotes:  have four embryonic structures that reside outside the embryo to help it survive:

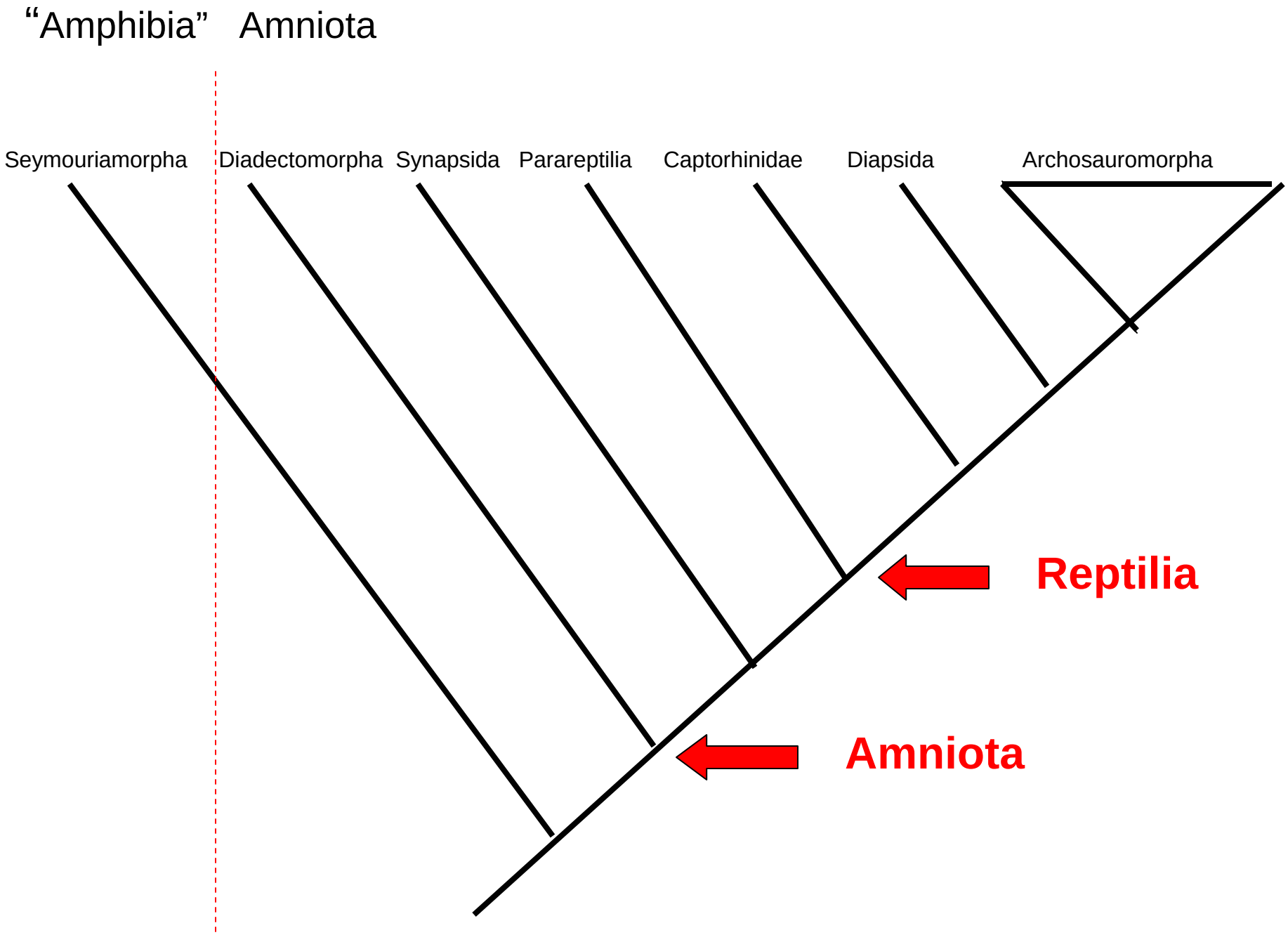
- Amnion
- Yolk sac
- Chorion
- Allantois


Other Sarcopterygians
Panderichthyids
Ichthyostegalia
Dissorophoids
Lissamphibia
Anthracosauria
Seymouriamorpha
Diadectomorpha
Amniota
Sarcopterygii
Tetrapoda
The road to reptiles



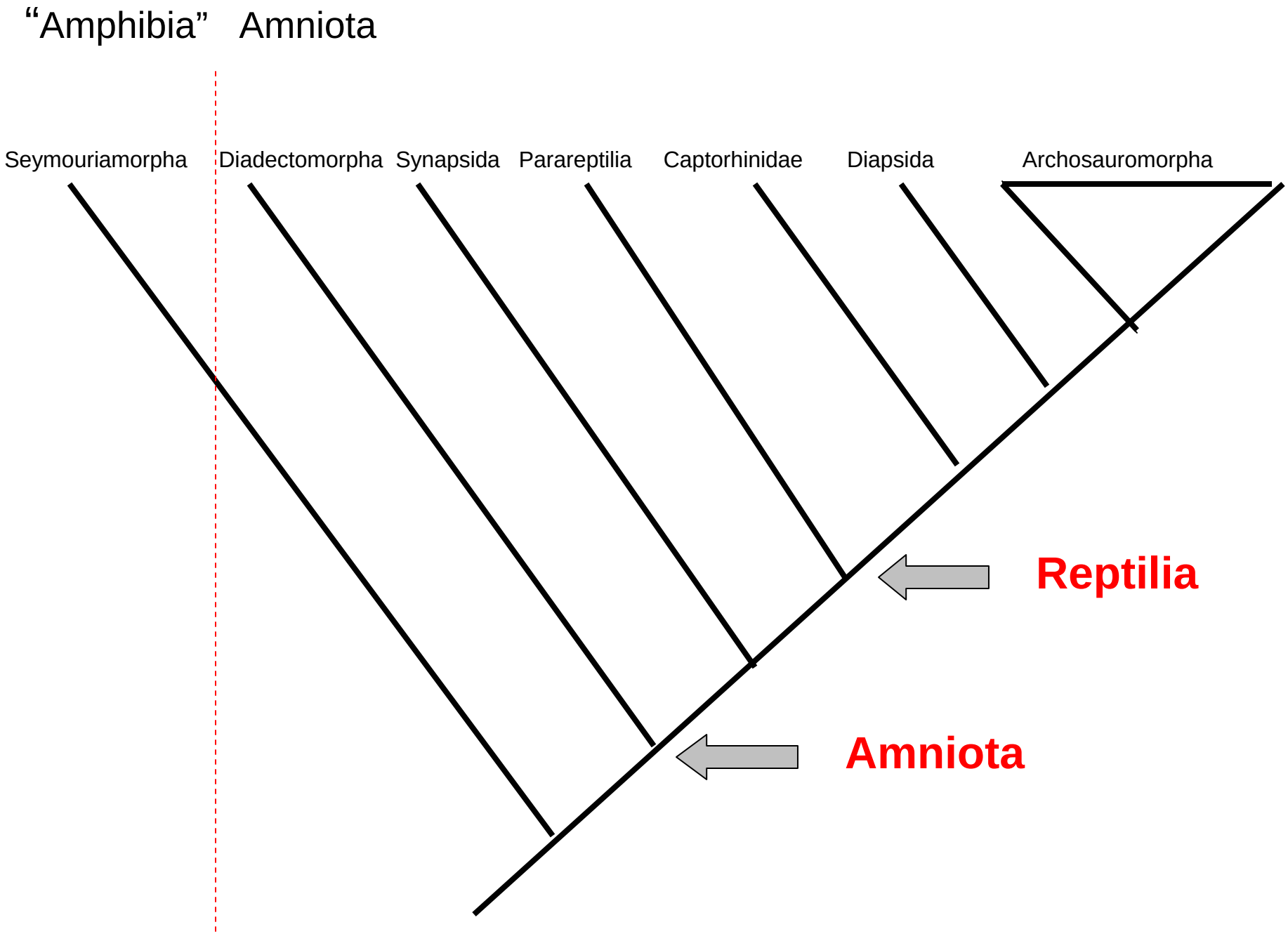

Diadectomorpha:

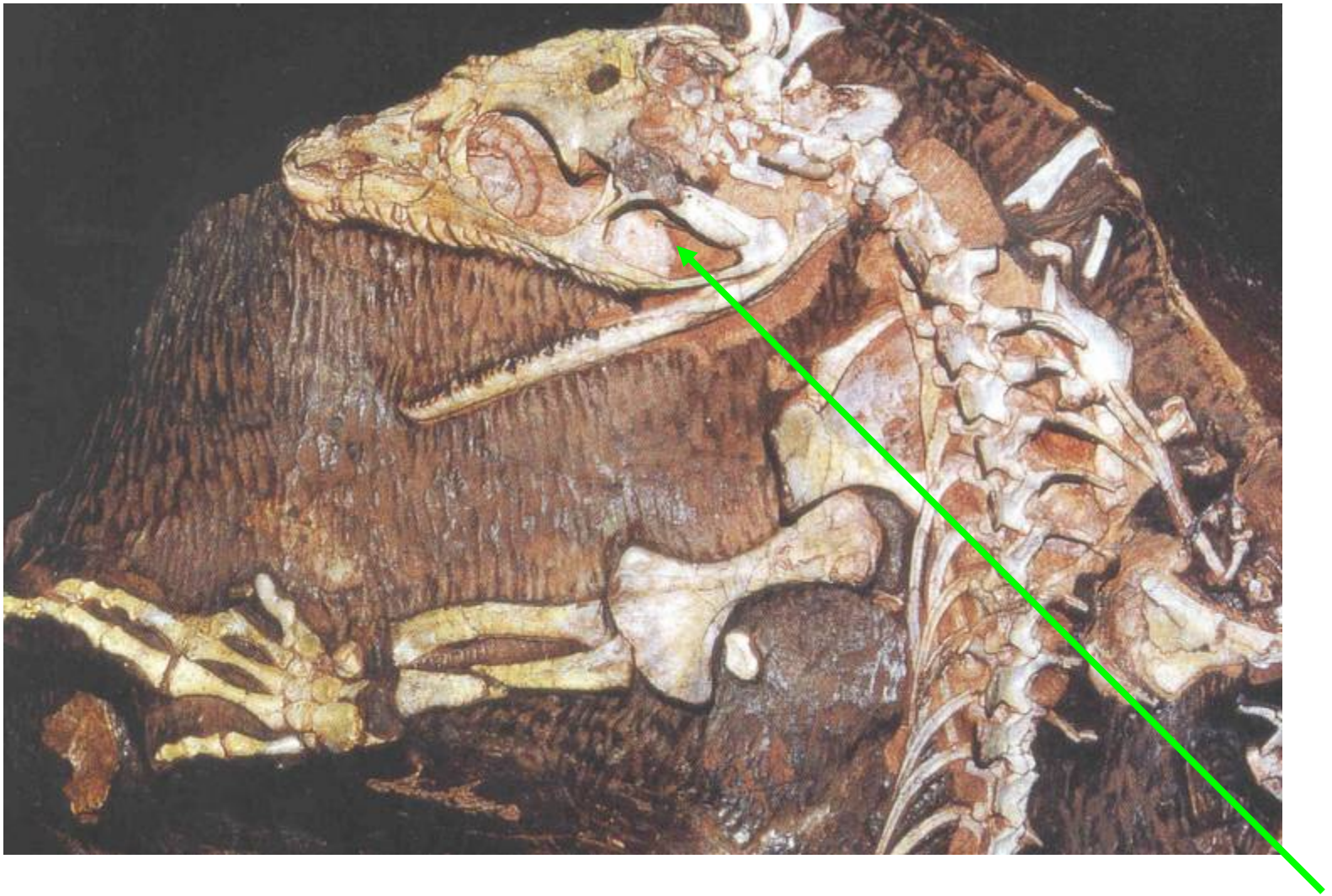
- No intertemporal bone like other amniotes
- Very terrestrially adapted


"Amphibia"
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota

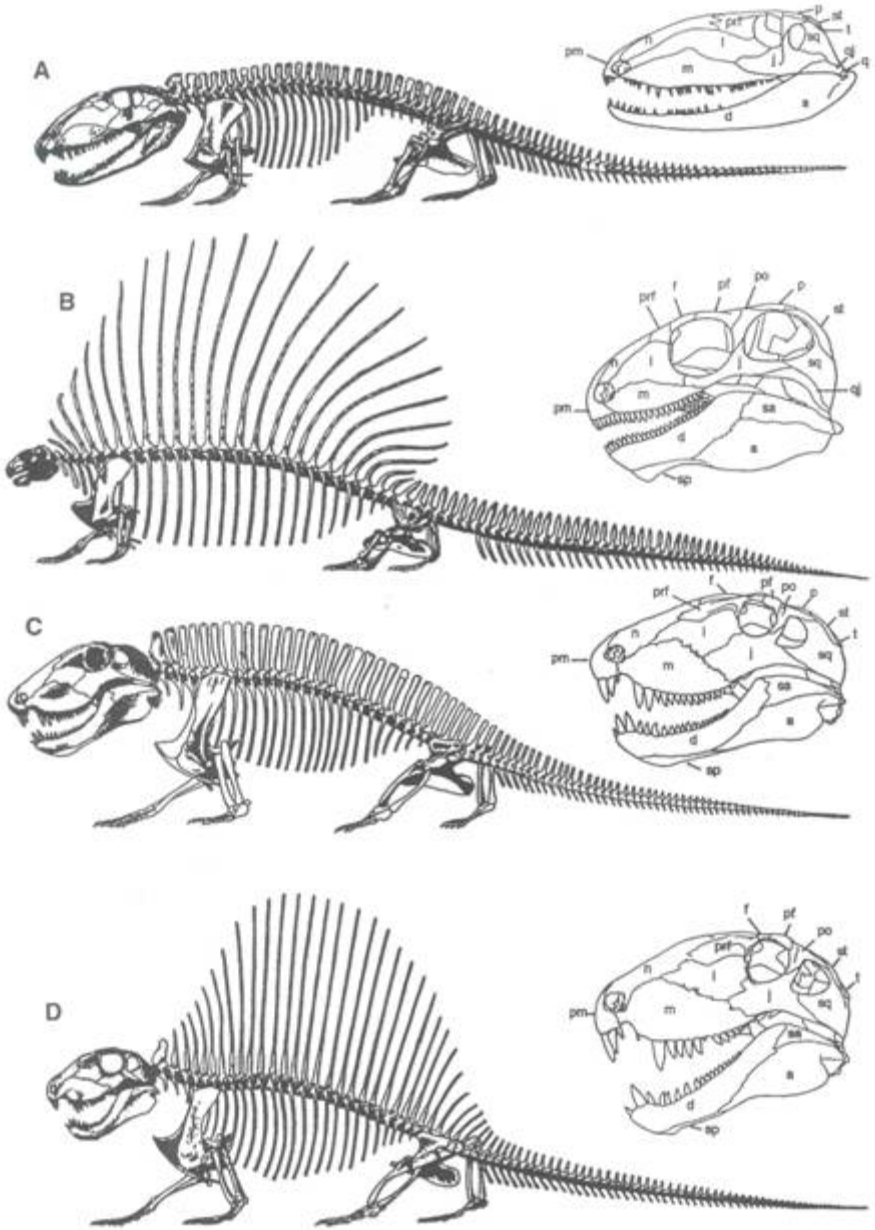
Amniotes:  have four embryonic structures that reside outside the embryo to help it survive:

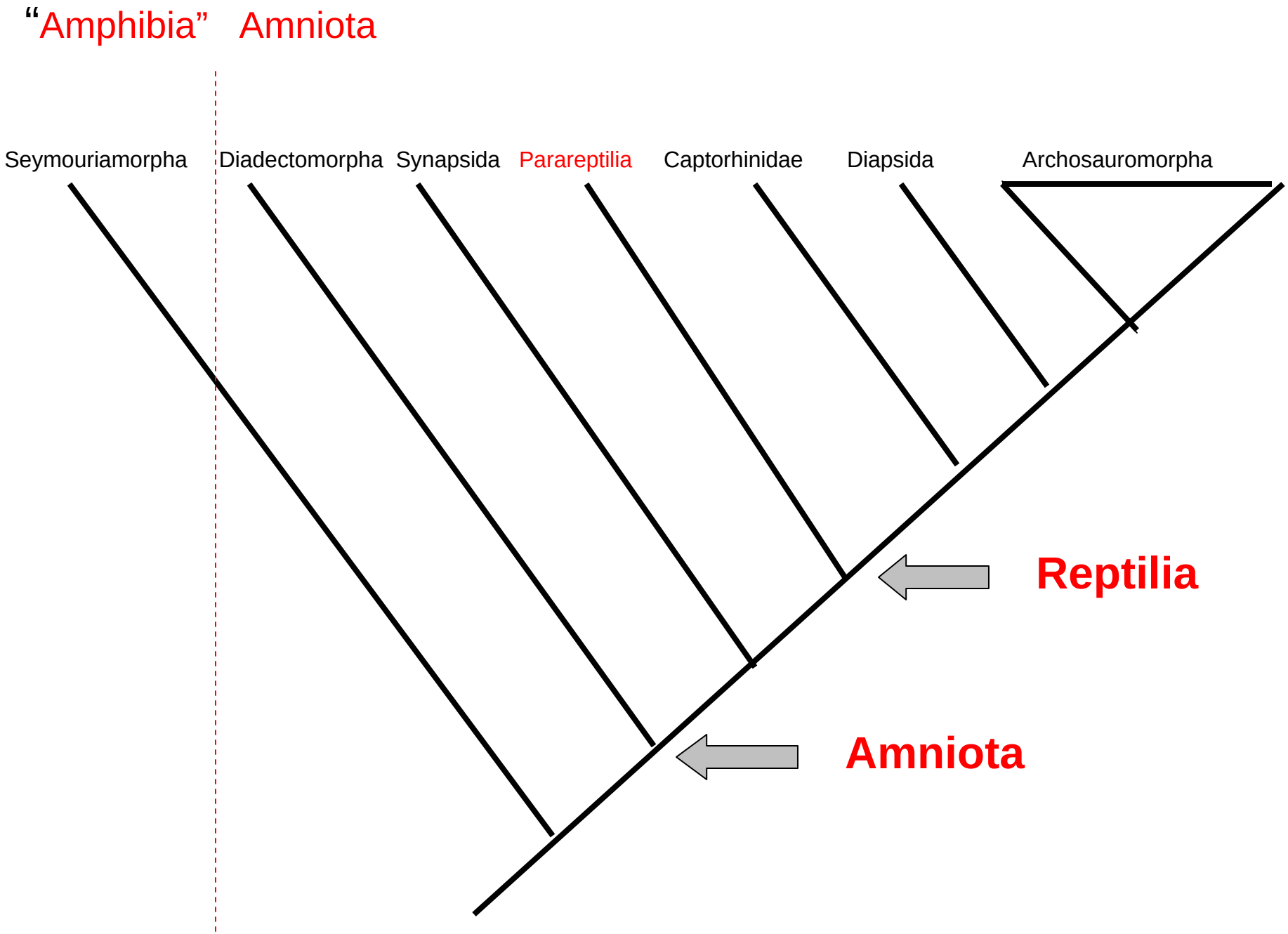
- Amnion
- Yolk sac
- Chorion
- Allantois


“Amphibia”
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota



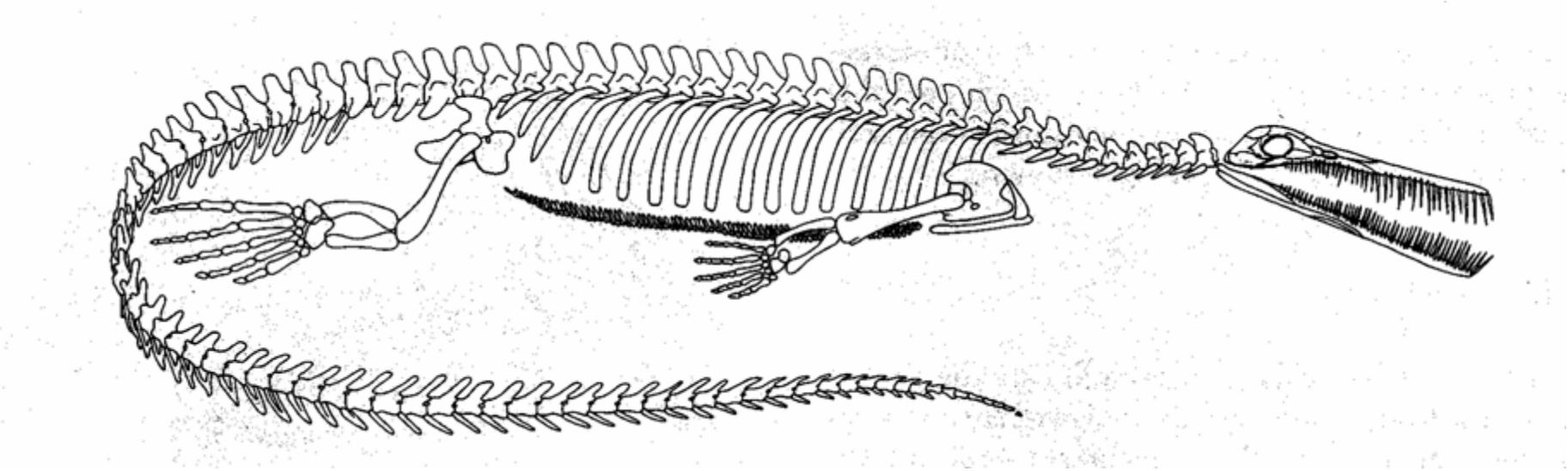
Basal Synapsida (“Pelycosauria”): A single opening on side of skull


A
pm
n
prf
l
m
p
st
t
sq
qj
d
a
B
prf
f
pf
po
p
st
n
l
sq
pm
m
qj
sa
d
a
sp
C
prf
f
pf
po
p
st
t
n
l
sq
pm
m
sa
a
d
sp
D
f
pf
po
st
prf
n
l
sq
pm
m
sa
a
d
sp

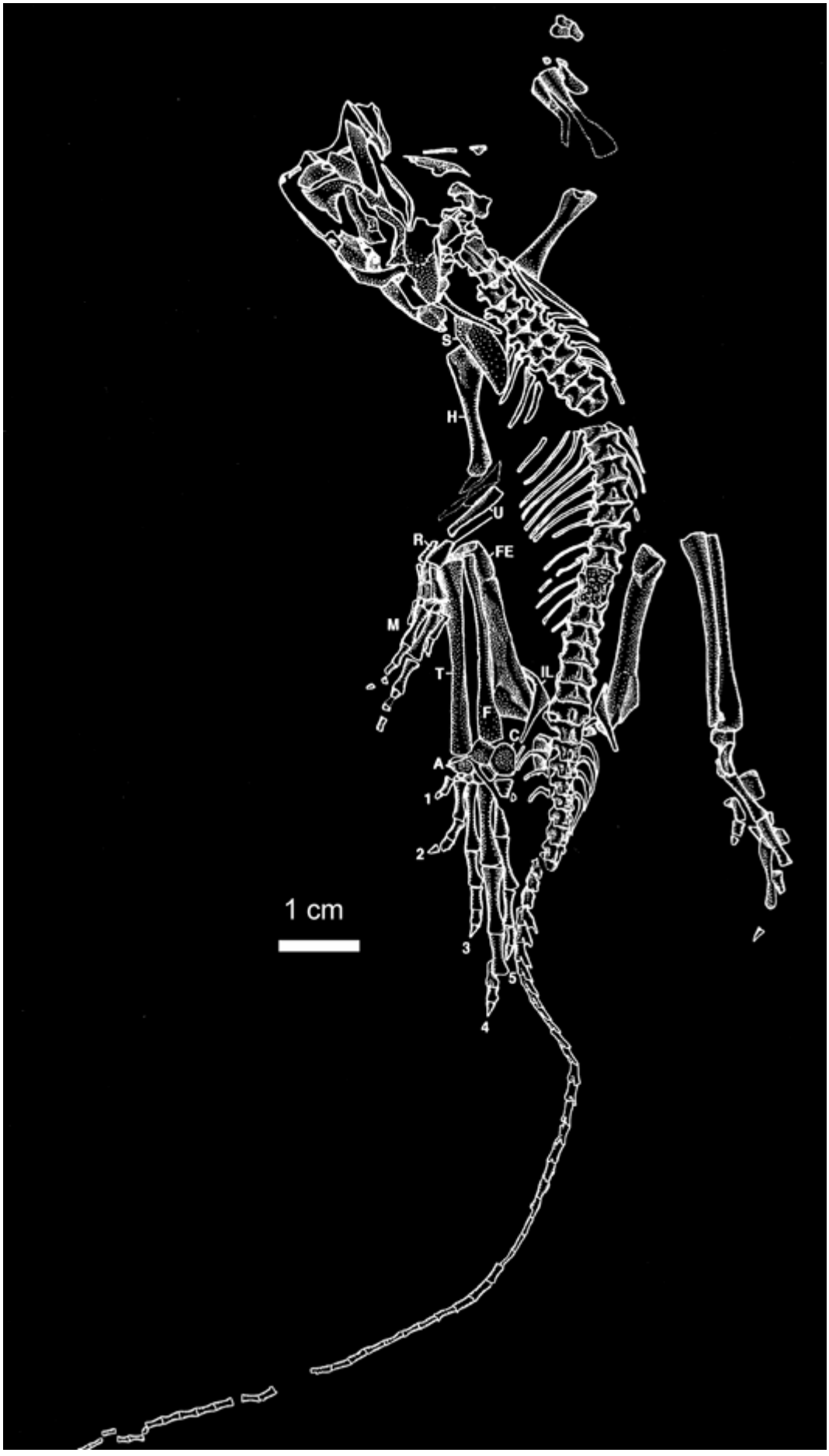

“Amphibia”
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota

# PARAREPTILIA Includes:

- Mesosauria
- Bolosauridae
- Procolophonia
- Paraiesauria



*Mesosaurus*: A member of Mesosauria


S
H
U
R
FE
M
T
IL
F
C
A
1
2
3
4
5
1 cm

*Eudibamus* reconstruction

NATIONAL GEOGRAPHIC

# Geographica

ART BY DOUGLAS HENDERSON

■ NGS RESEARCH GRANT

## A Reptile Runs Into History's Record Books

Dashing about on its hind legs, this little creature, whose fossilized bones (right) were found in central Germany, was an all-time original: It's the earliest bipedal reptile known, predating dinosaurs by 50 million years.

About nine inches long from nose to tail, the newly discovered—and as yet unnamed—reptile comes from rocks about 280 million years old, says Stuart Sumida of California State University, who with David Berman of the Carnegie Museum of Natural History and a German colleague, Thomas Martens, unearthed the remains. Its hind limbs were nearly twice as long as its front legs, proportions never seen so early in the fossil record. "It could scratch its nose with its toes, but not its butt with its fingers," Sumida says.

Digging in the Thuringian forest, the team found that beneath the vegetation, "the rocks are amazingly similar to those of classic red rock country in the American Southwest." When the reptile lived, Europe and North America were connected in the supercontinent Pangaea, though a mountain range limited traffic between them. But the researchers also uncovered fossils of several early land vertebrates previously found only in North America, suggesting they traveled through gaps in the mountain range.

## Marine Archaeology by Robot

Lights, cameras, action: Robot Super Achille photographs an amphora from a ship that sank off Marseille in the first century B.C. The robot's images helped identify dozens of amphorae as products from Italy's Adriatic coast. In this multifaceted French experiment in diverless underwater archaeology, the support boat *Minibex* used satellite data to maintain a stable position so that its onboard computers could create three-dimensional maps of the site. Suspended from the support vessel, fans gently dislodge sediment burying the ship. A two-person minisub ferried archaeologists to the seafloor for a close look at the wreck. The French government's underwater archaeological unit DRASSM and the private firm COMEX joined in the project, one of several efforts worldwide using high-tech tools in underwater archaeology. This ship lies in water 210 feet deep, but Super Achille can explore to a depth of 2,000 feet. It can also deploy parachutes to float artifacts to the surface.

ALEXIS ROSENFELD, PHOTOCEANE



GEOGRAPHICA

# 地球新発見

ART BY DOUGLAS HENDERSON

■ 協会支援プロジェクト

## ドイツで発見！二足で歩く爬虫類の祖先

後ろ足で駆けるこの小さな生き物は、最近ドイツ中部で化石(右)が発見された、二足歩行する最古の爬虫(はちゅう)類。恐竜よりも5000万年前に生息していた。

約2億8000万年前の岩盤から見つかったこの爬虫類の体長は23cmほどで、名前もまだ付いていない。発掘したのは、米国カリフォルニア州立大学のスチュアート・スミダとカーネギー自然史博物館のデビッド・バーマン、ドイツ人の同僚トーマス・マーティンズの3人。後ろ足は前足の2倍も長く、こうした特徴を持つ化石がこれほど古い時代の地層から発見されたのは今回が初めてだ。

「後ろ足で鼻をかけても、前足でお尻をかいたりはできないでしょうね」とスミダ。化石が見つかったのはチューリンゲンの森で、「その岩盤は、米国南西部の赤茶けた岩によく似ている」と、発掘チームは指摘する。

実際、この爬虫類が生きていた当時、ヨーロッパと北米大陸はパンゲアと呼ばれる巨大な一つの大陸だったが、山脈が生物たちの移動を妨げていた。だが、これまで北米大陸でしか発見されていなかった初期の陸上脊椎動物の化石がドイツでも何点か発掘された事実は、動物たちが当時山脈の谷間を縫って往来していたことをうかがわせる。

## ロボットが水中考古学調査に活躍

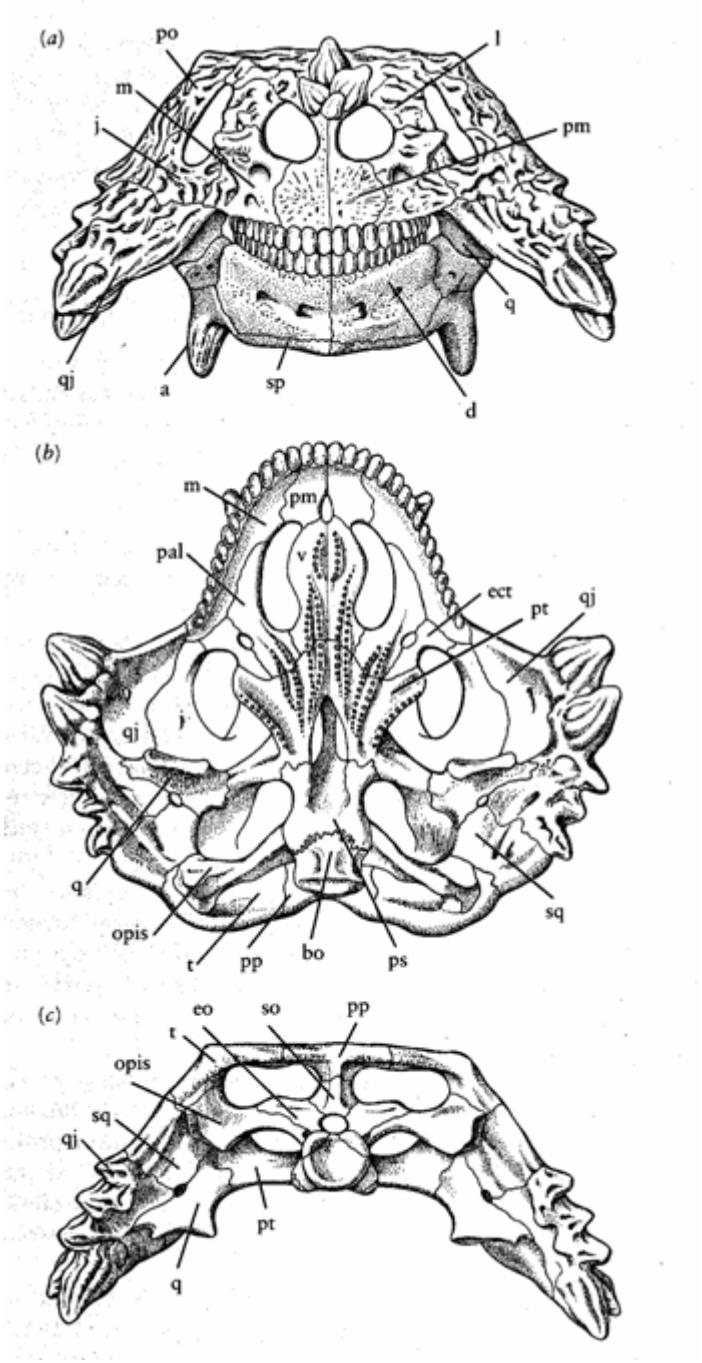
写真左下は、紀元前1世紀にマルセイユ沖で沈んだ船の積み荷、アンフォラ(両取っ手付きの壺)と、これを撮影したフランスの水中ロボット「シュペール・アシル」。ロボットの映像から、10数個のアンフォラがイタリアのアドリア海沿岸で作られたものと確認された。

今回のフランスの水中考古学調査は、ダイバーに頼らず、この装置を活用している。サポート船は衛星データを使って一定の場所にとどまり、コンピューターで調査海域の三次元地図を作成。これをもとに、サポート船から吊り下げたファンをそっと動かして船体の堆積物を取り除いた後、小型潜水艇で考古学者が現場へ向かい、周辺で沈没船を観察した。

ハイテク技術を活用するこのプロジェクトにはフランス政府の水中考古学チームと企業が参加。沈没船は水深65mの海底にあるが、「シュペール・アシル」号は600mまで潜水でき、浮きを使って遺物を水上へ浮上させることも可能という。

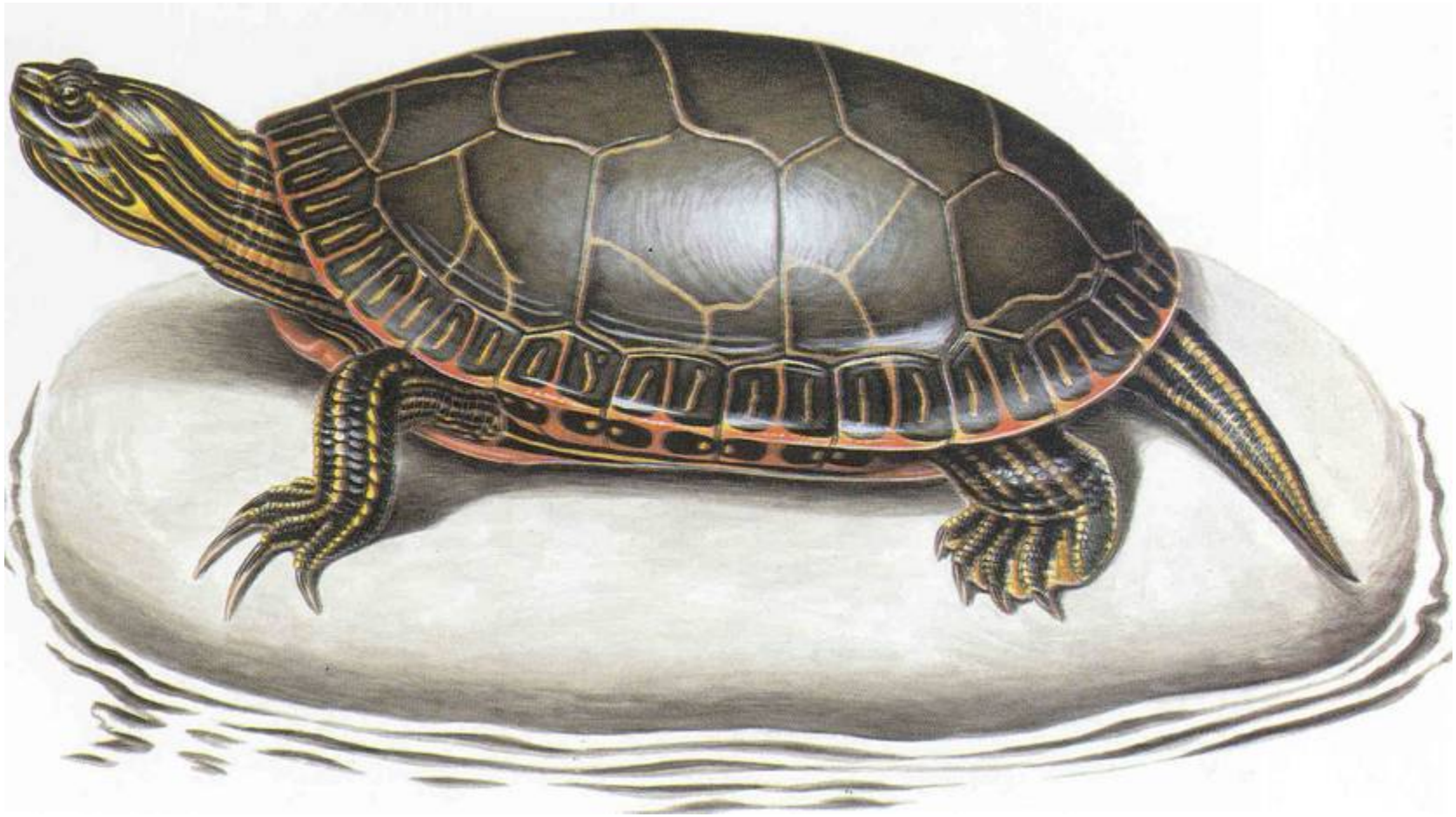
ALEXIS ROSENFELD, PHOTOCEANE

*Bradysaurus*:  A member of the Parieasauria

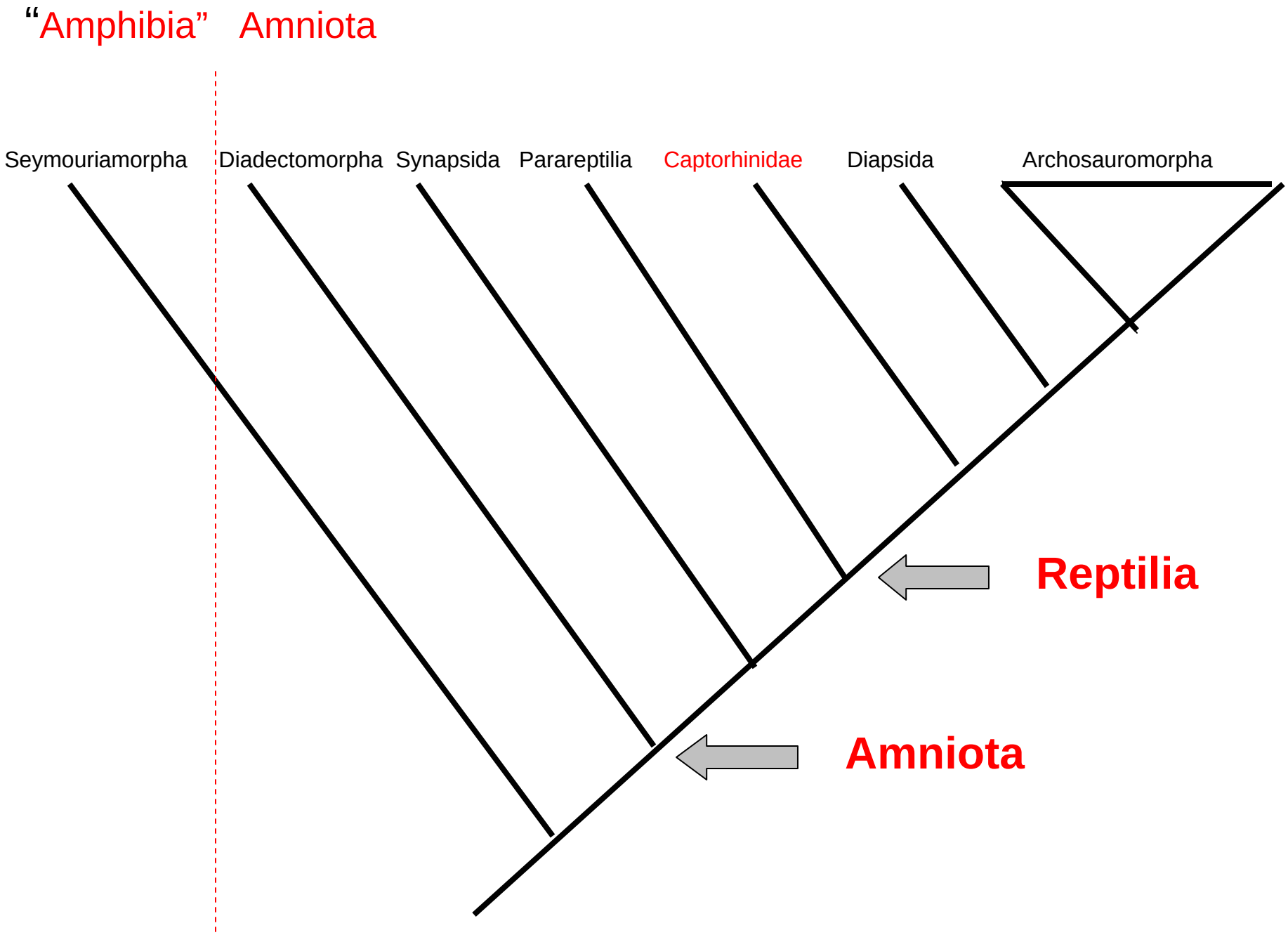


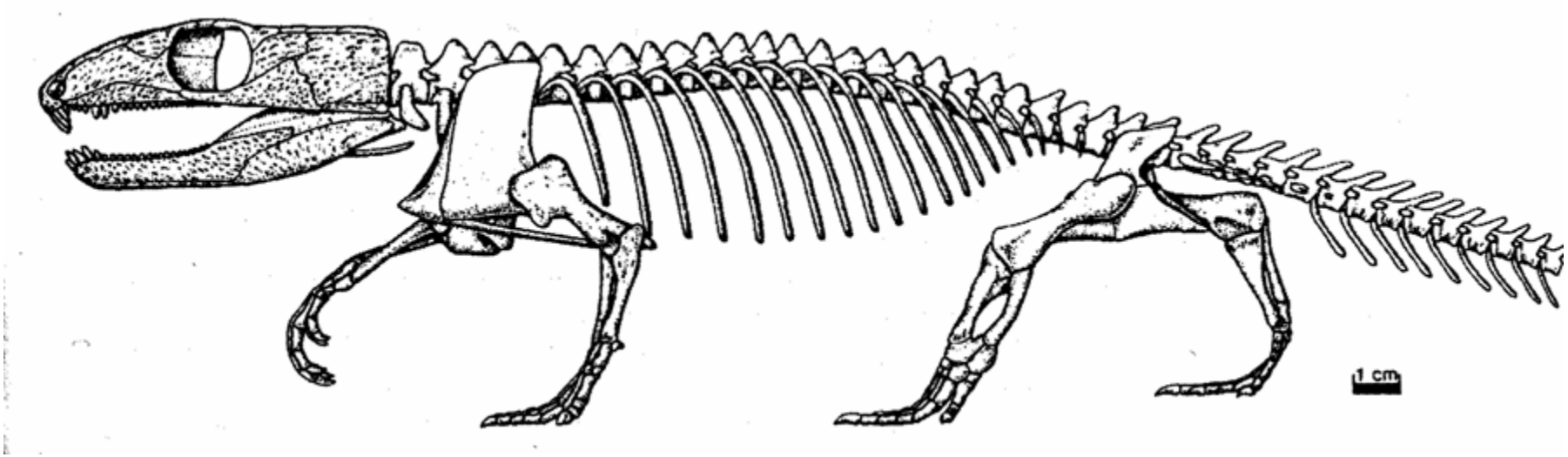

Parieasaurs have lumpy, bumpy skulls

*Scutosaurus*

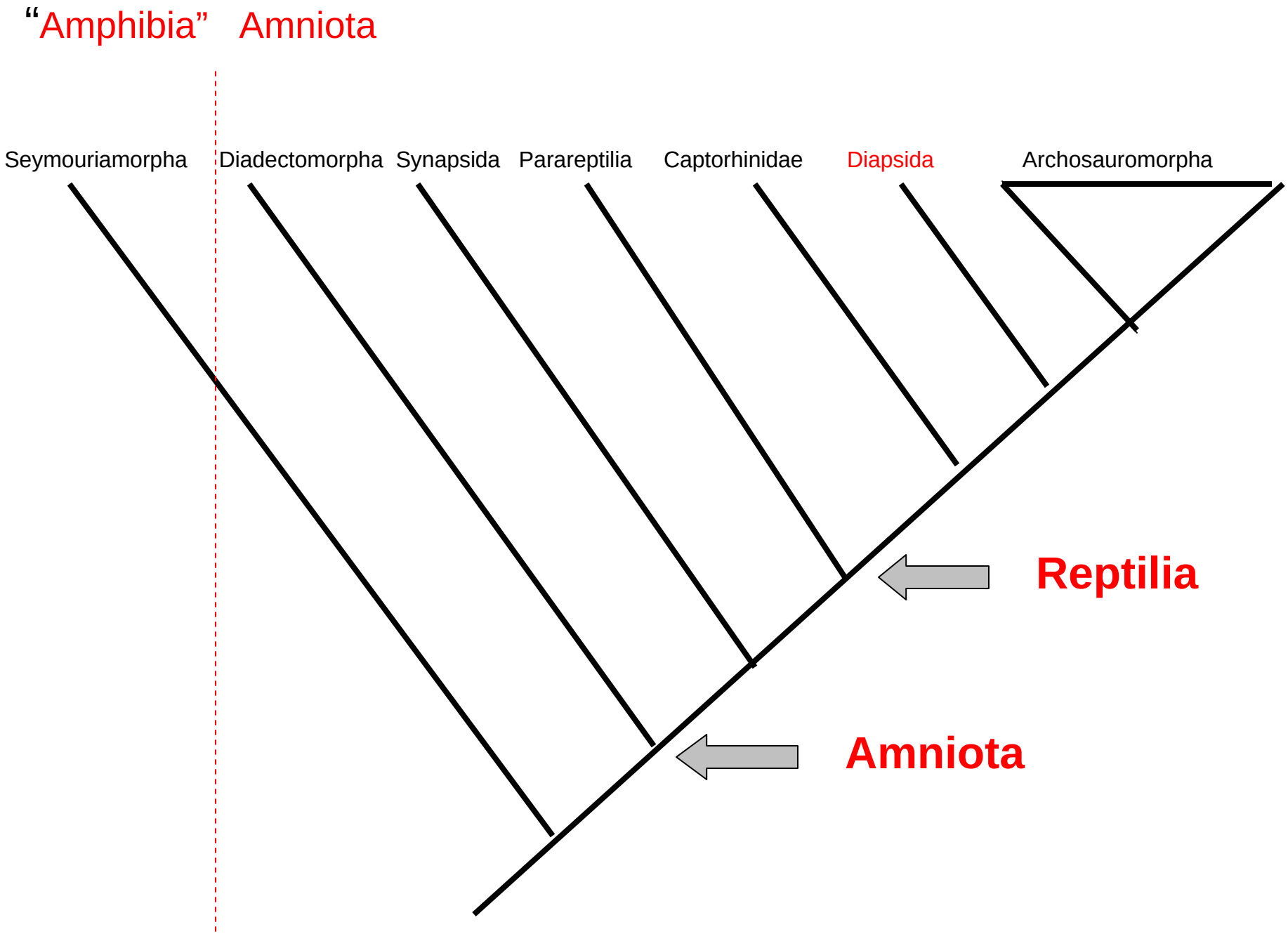


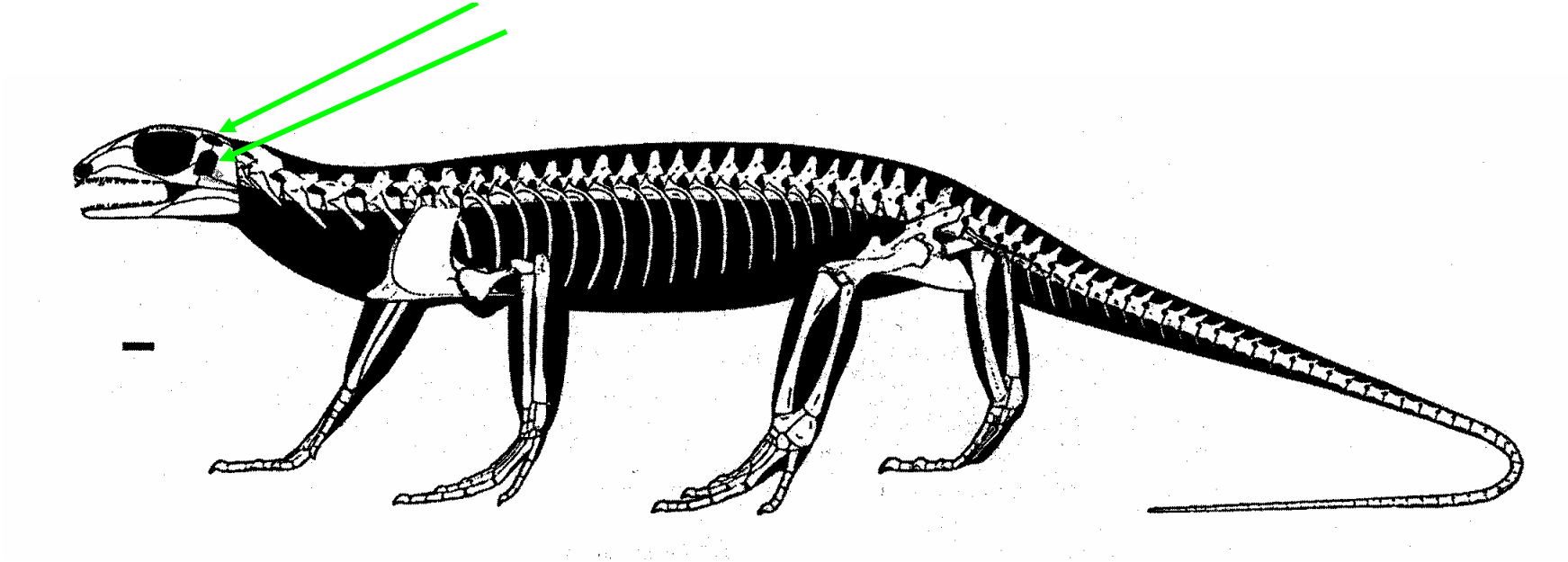
Common North American painted turtle


"Amphibia"
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota




Basal Captorhinid: *Eocaptorhinus*


"Amphibia"
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota



Basal Diapsid: *Petrolacosaurus*

Note: TWO holes (fenestrae) on side of skull

Known back to Late Pennsylvanian

Diapsida includes:

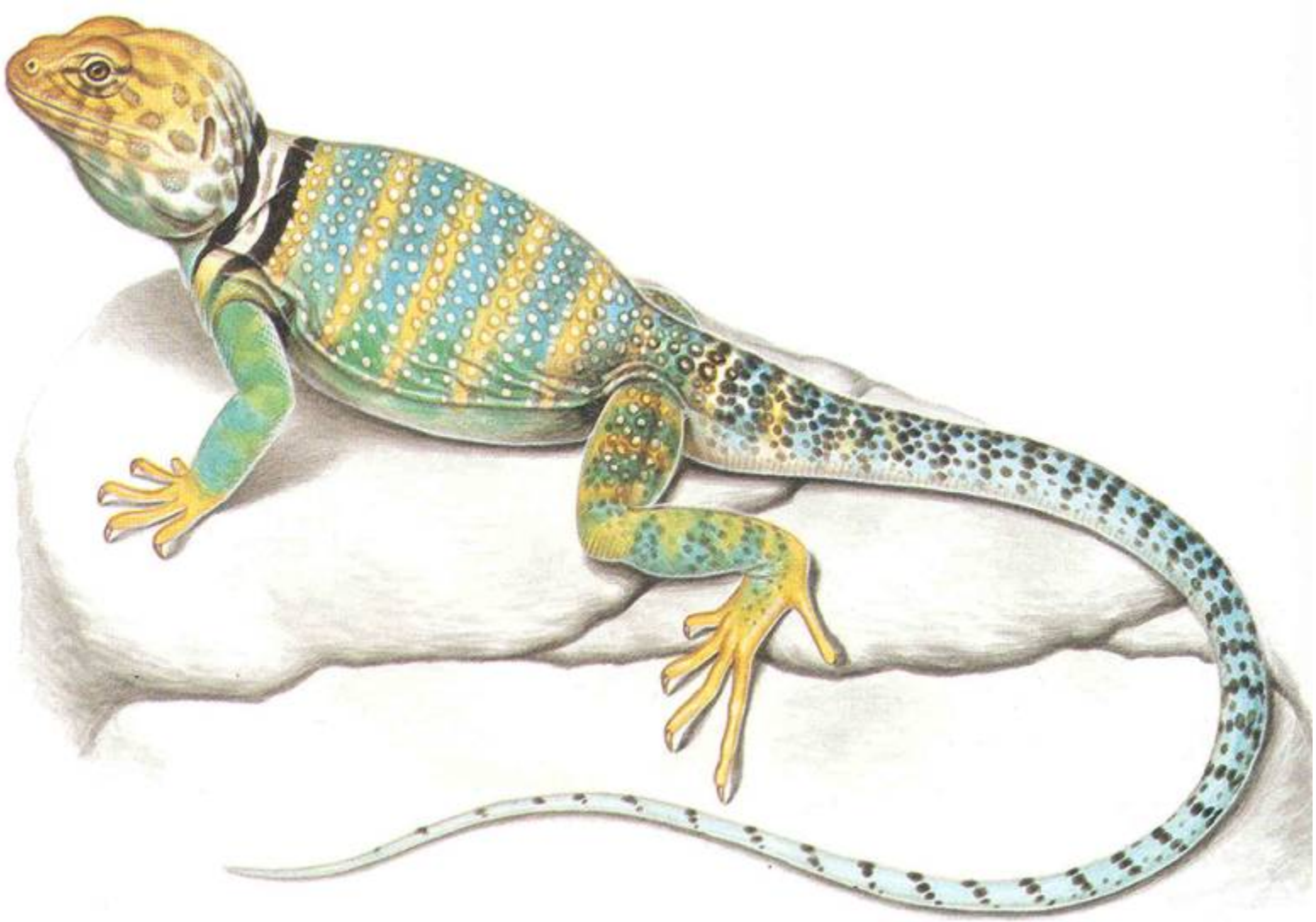
- Many extinct forms
- Squamata
- Archosauromorpha

Squamata includes living lizards and snakes.

# Squamata:

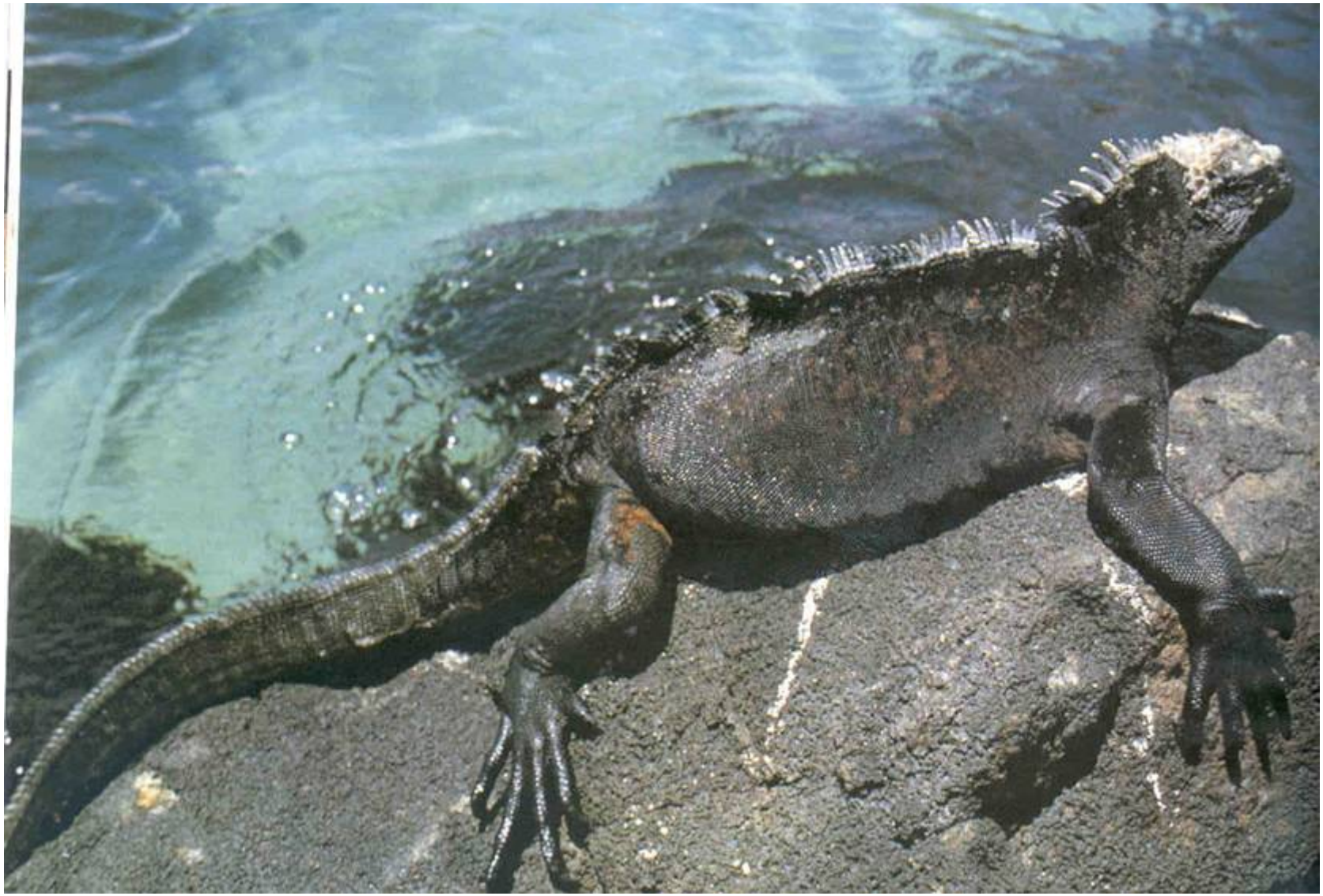
- Lizards (including limbless lizards)
- Snakes

# *Crotaphytus* (local, “collared lizard”)

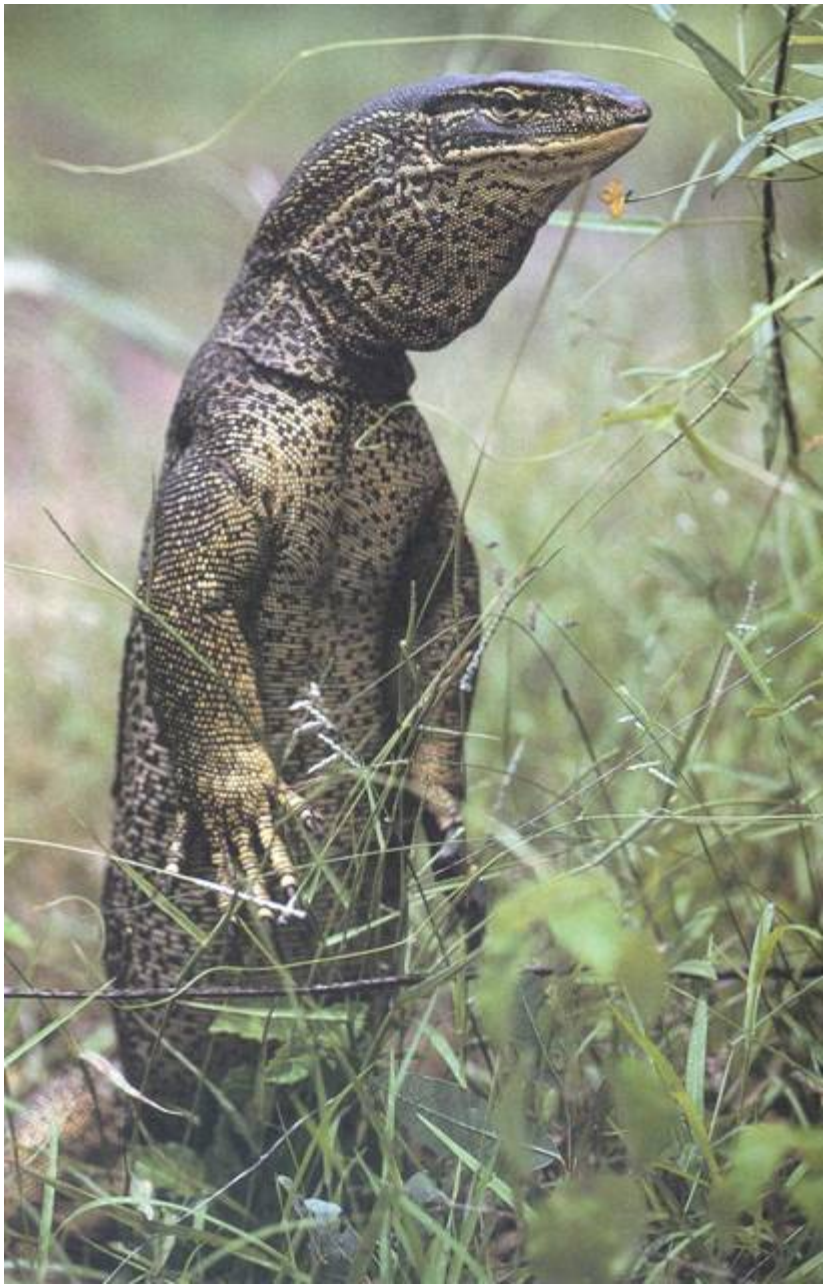


“Horny-toads” are not toads.

# Komodo dragon – largest living lizard



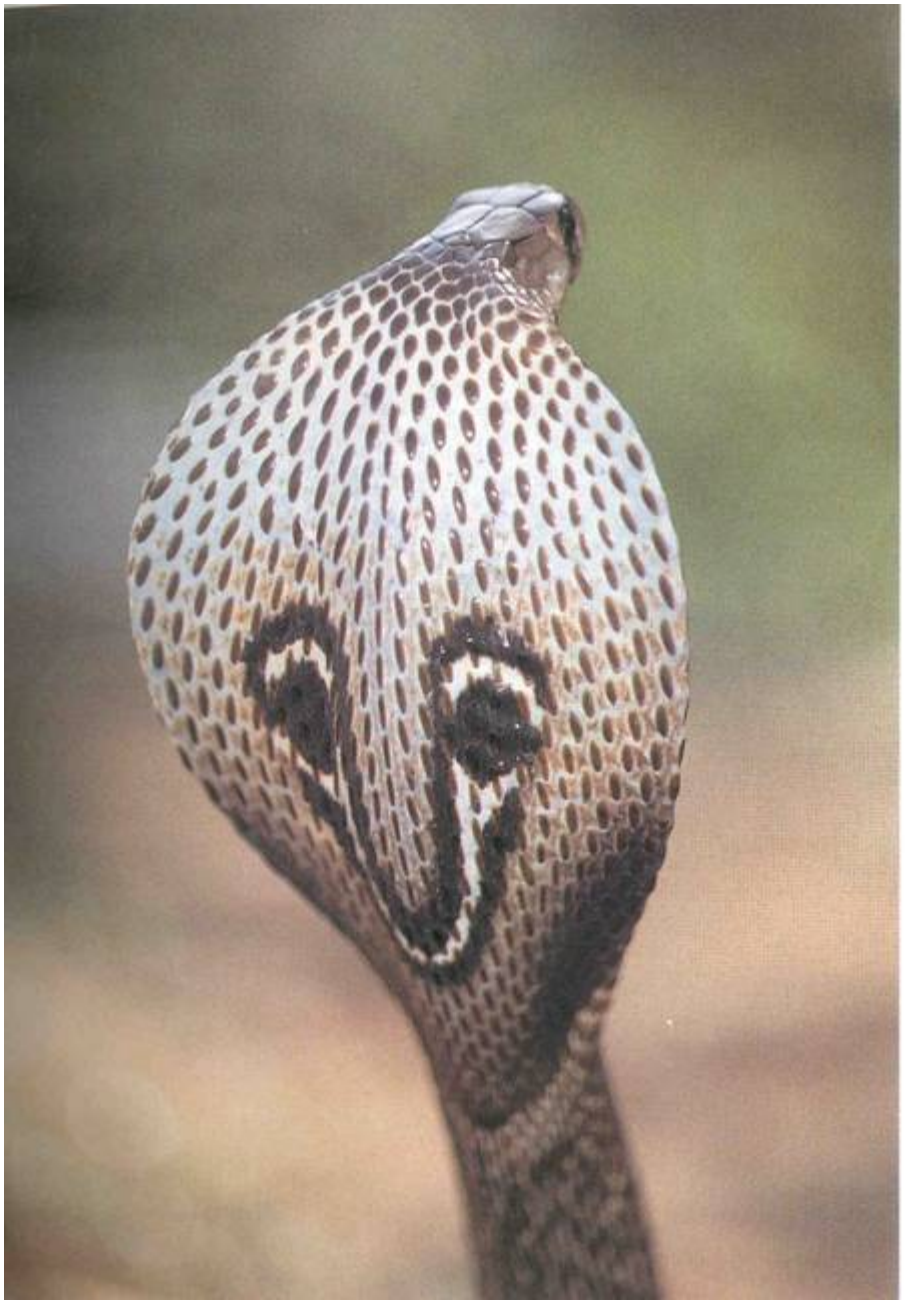
Meditteranean chaemelon



Monitor lizard

Amphisbaenia:  limbless lizards

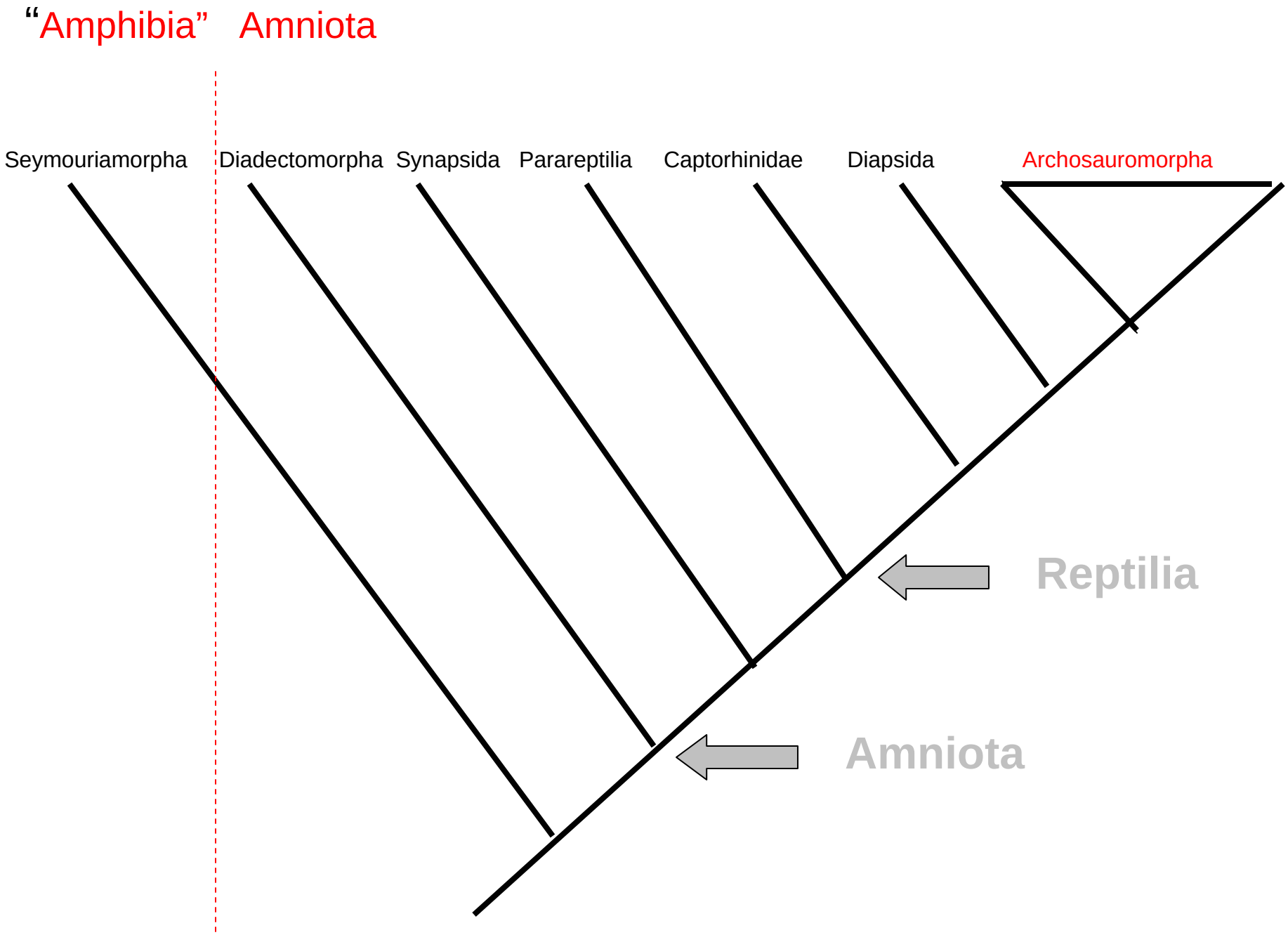
Amphisbaenia:  limbless lizards



Cobra

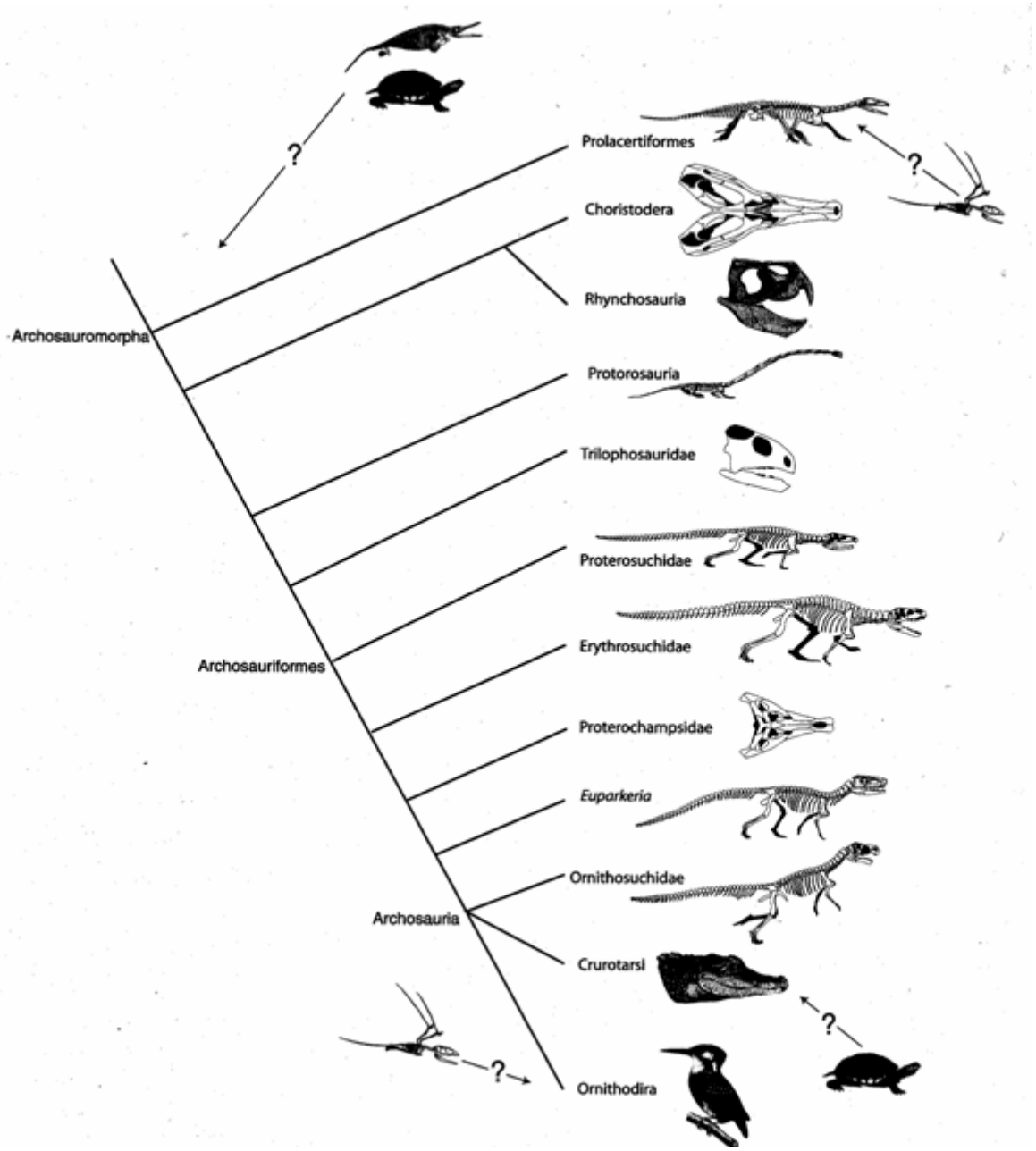
Hog-nosed pit viper

Long-nosed vine snake


"Amphibia"
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota

# Archosauromorpha Includes:

- Crocodilians
- Numerous other extinct groups
- Pterosauria
- Dinosaurs
- Birds


Prolacertiformes
Choristodera
Rhynchosauria
Archosauromorpha
Protorosauria
Trilophosauridae
Proterosuchidae
Erythrosuchidae
Archosauriformes
Proterochampsidae
Euparkeria
Ornithosuchidae
Archosauria
Crurotarsi
Ornithodira
?
?
?
?

Archosauria includes Crocodilians, Pterosaurs, Dinosaurs (including Birds), and a variety of other extinct groups.

Crocodylomorpha: Still extant - known from the Middle Triassic to present day.

In brief:

•Low, flat skull.

•All but a few marine forms have 24 vertebrae cranial to the hip and 2 sacral vertebrae for attaching to the hip.

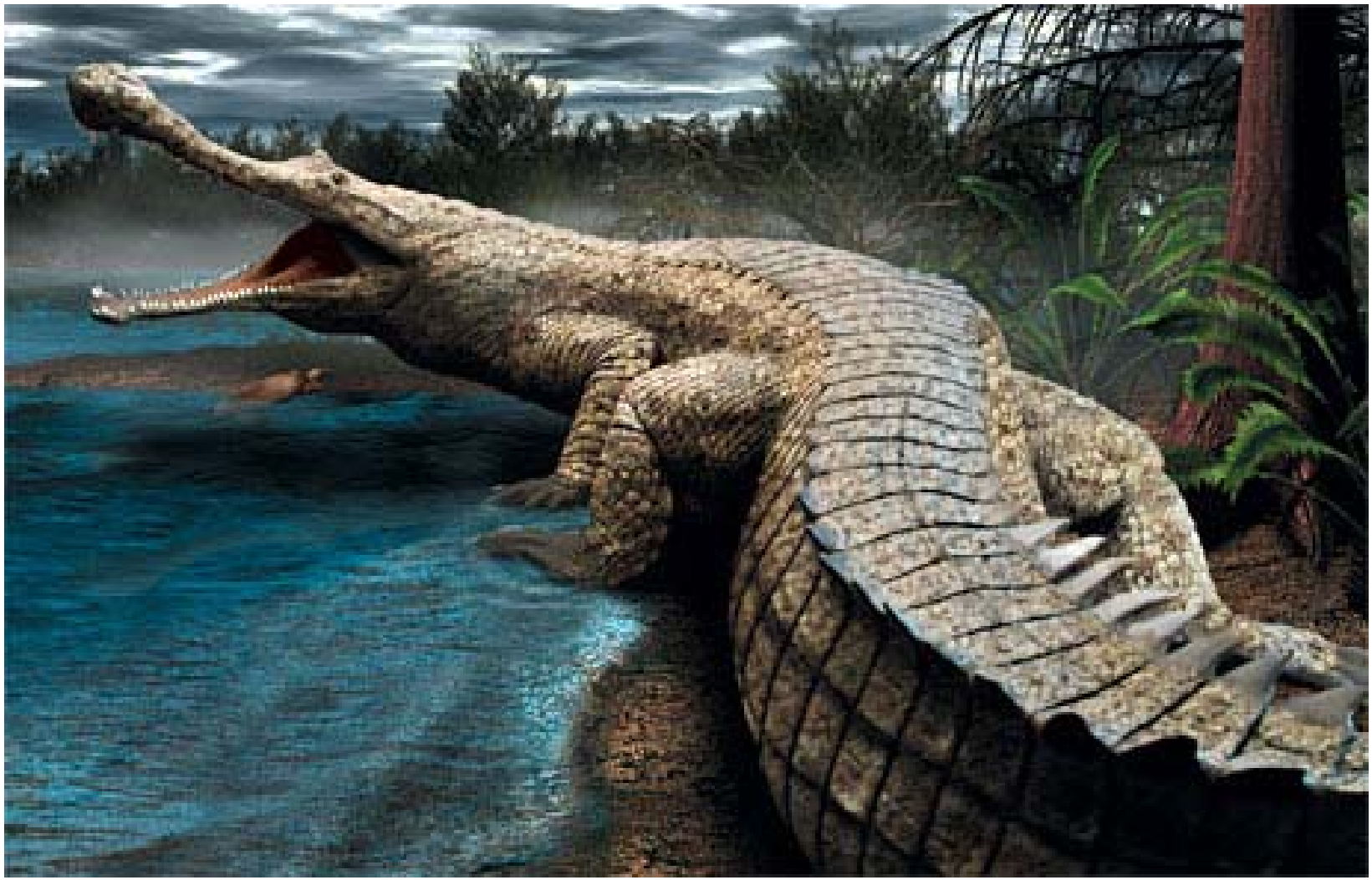
*Alligator mississippiensis*

Note presence of bony “scutes” or osteoderms in skin.

Crocodilians are capable of a variety of types of locomotion: swimming; slow-sprawling walk; a moderate speed “high walk;” and even galloping in some young or smaller ones.

Nile crocodile

Some crocodilians have extremely complex social behavior and communication.



Reconstruction of *Sarcosuchus imperator* (“Supercroc”)

Over 40 feet long.

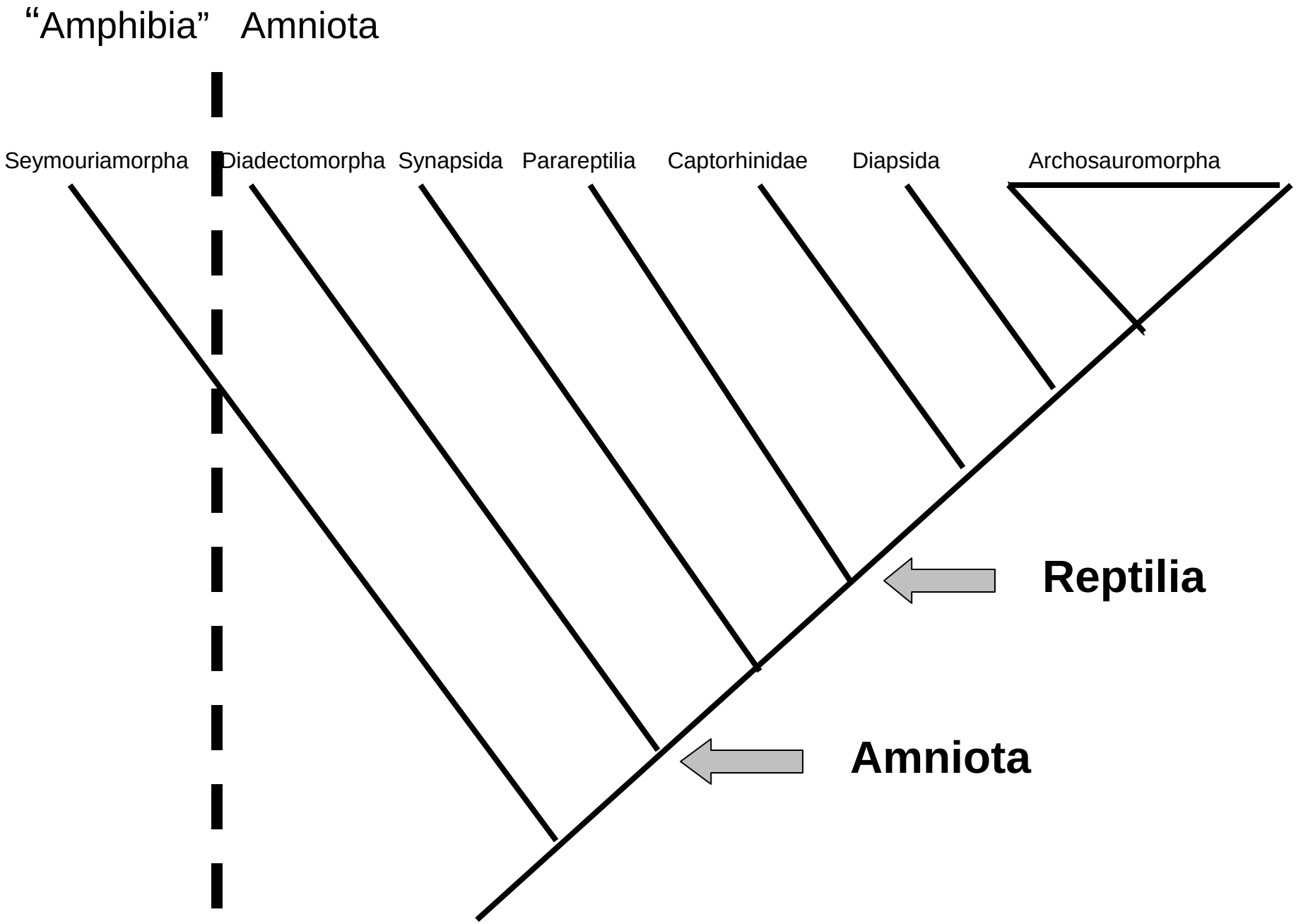
# The Diversity of Extinct Marine Reptiles Examples of Convergent Evolution

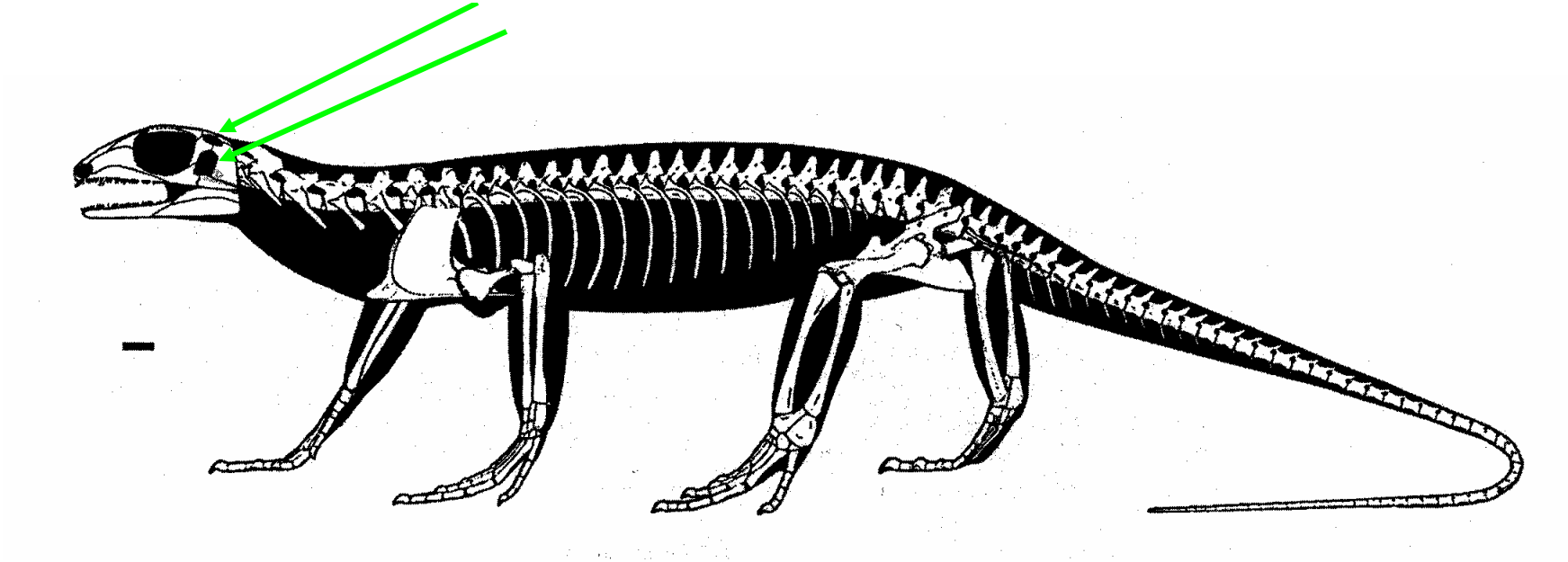
*“Duria antiquior”*

- Mesozoic marine reptiles are not dinosaurs.

- All are a variety of diapsid reptilies.

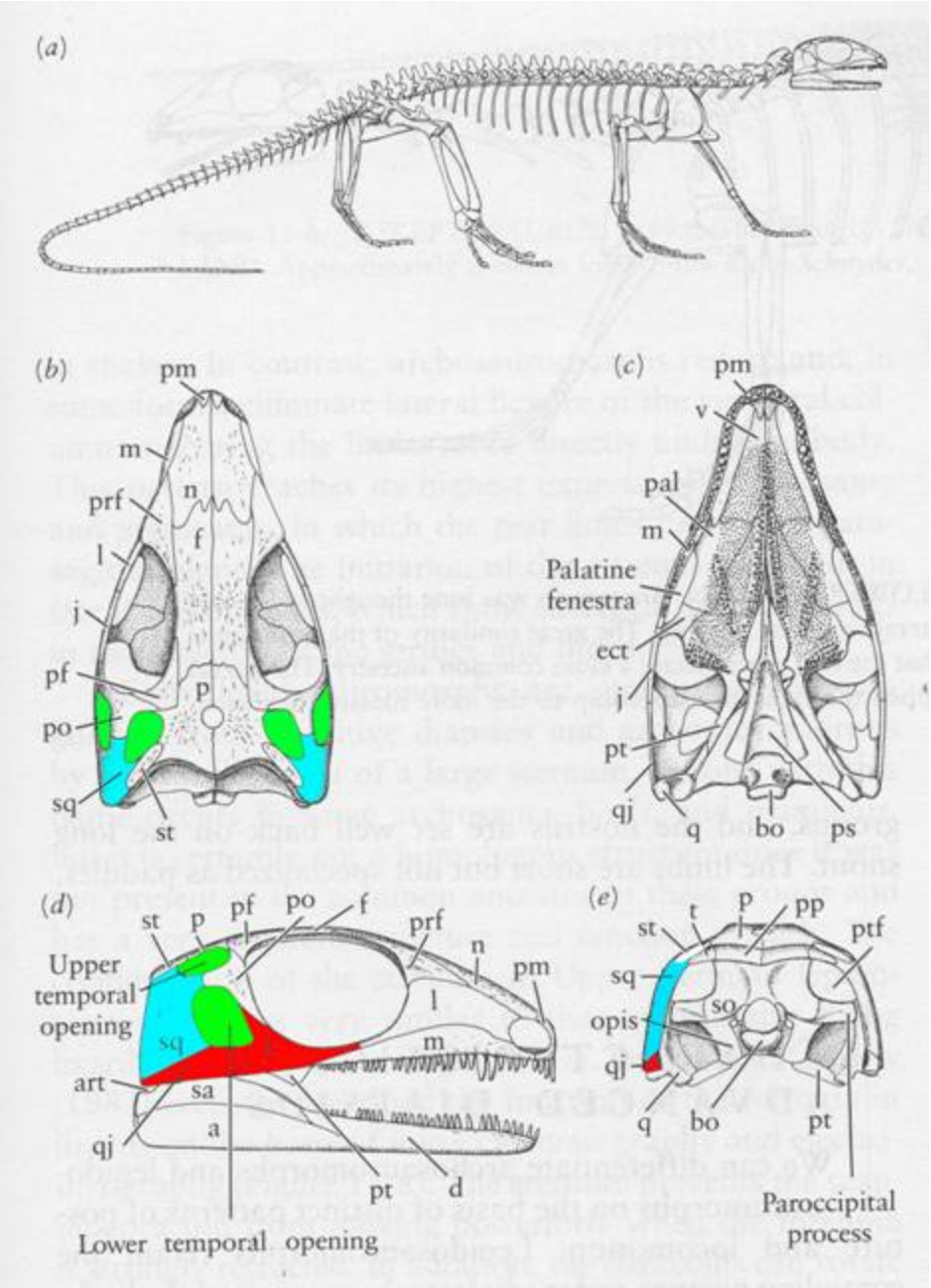
- We will survey them from approximately more primitive diapsid derivatives to somewhat more derived diapsid derivatives.


“Amphibia”
Amniota
Seymouriamorpha
Diadectomorpha
Synapsida
Parareptilia
Captorhinidae
Diapsida
Archosauromorpha
Reptilia
Amniota



Reall the Basal Diapsid: *Petrolacosaurus*

Note: TWO holes (fenestrae) on side of skull




*Petrolacosaurus*

A primitive diapsid reptile

Fenestrae color-coded green here

Mesozoic Marine Reptiles:

Diapsida

- Sauropterygia
  - Placodontia
  - Nothosauria
  - Pleisosauria
- Ichthyosauria
- Squamata
  - Mosasauria

Diapsida

Sauropterygia

Placodontia

Nothosauria

Pleisosauria

Ichthyosauria

Squamata

Mosasauria

Diapsida

Sauropterygia

Placodontia

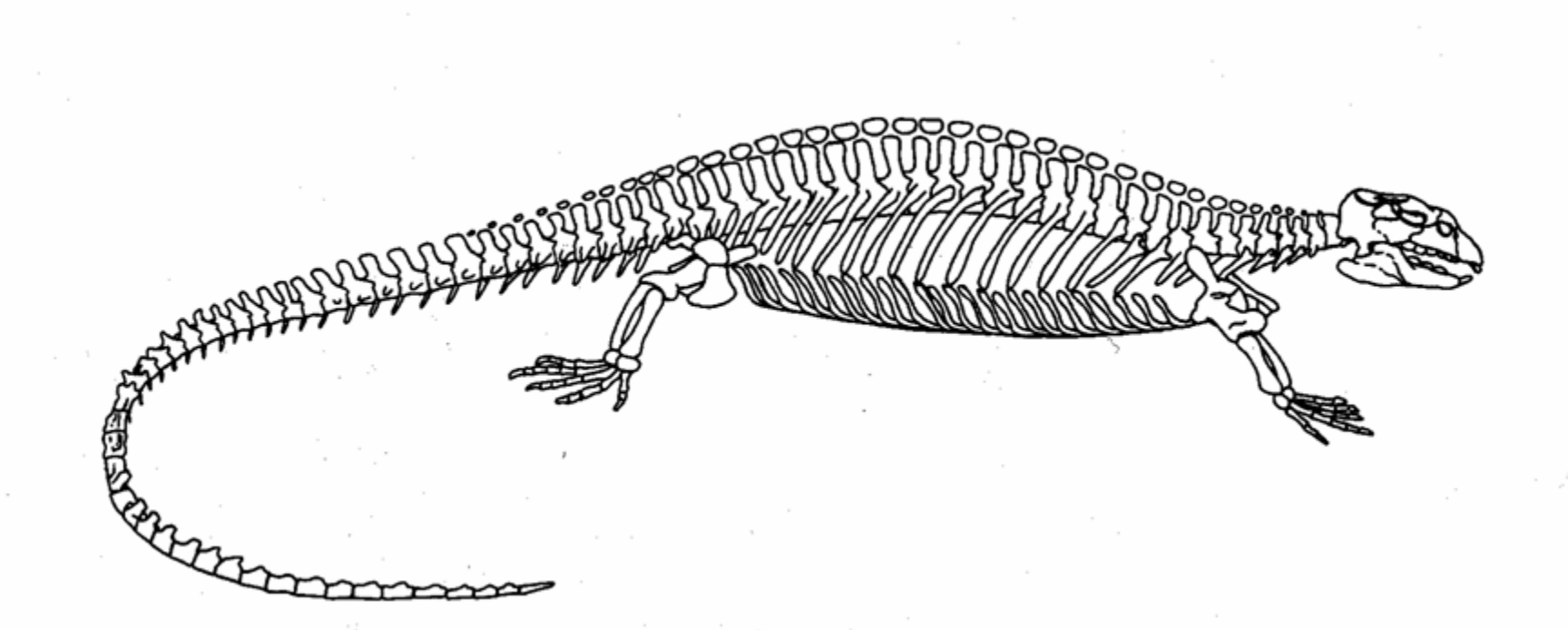
Nothosauria

Pleisosauria

Ichthyosauria

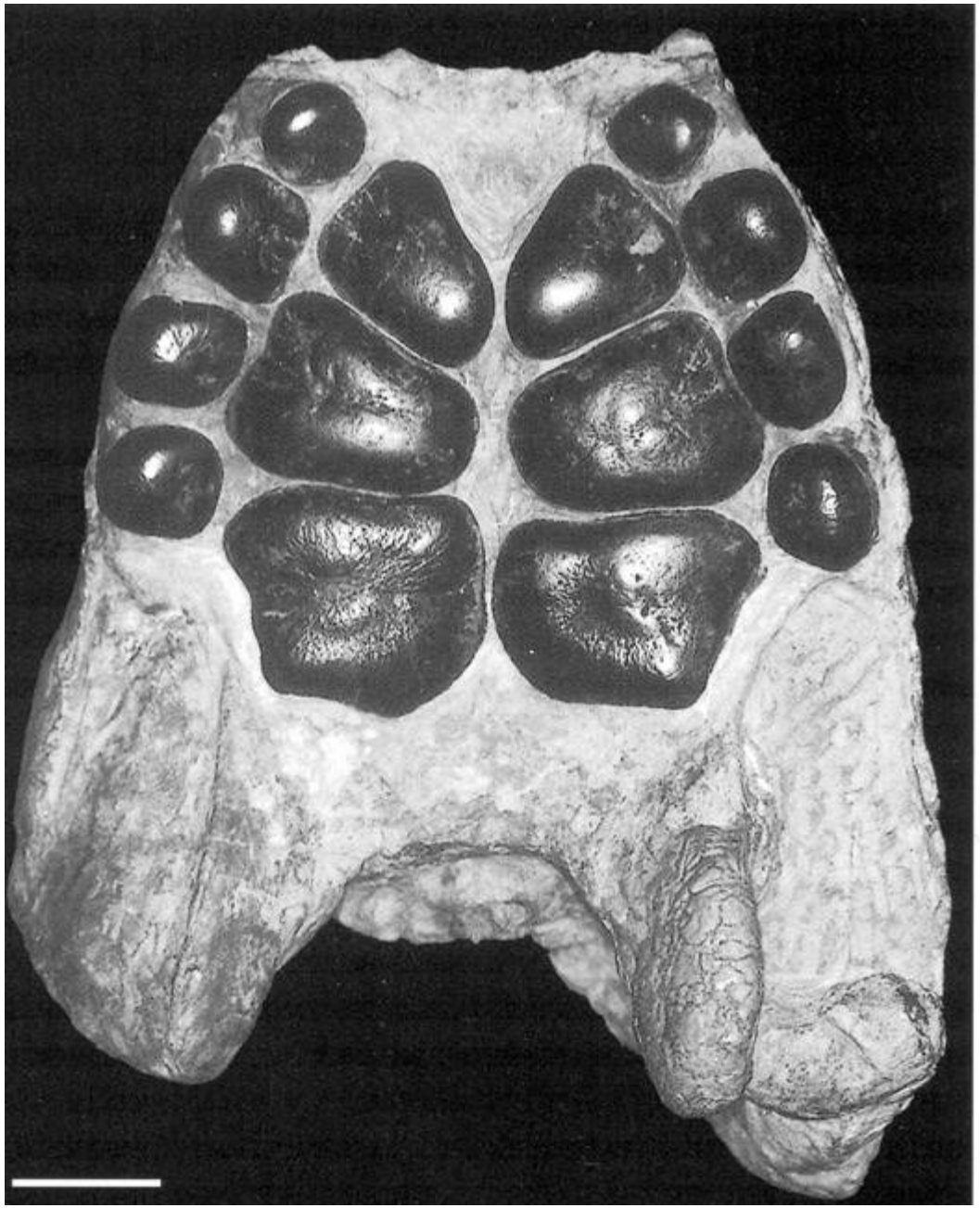
Squamata

Mosasauria



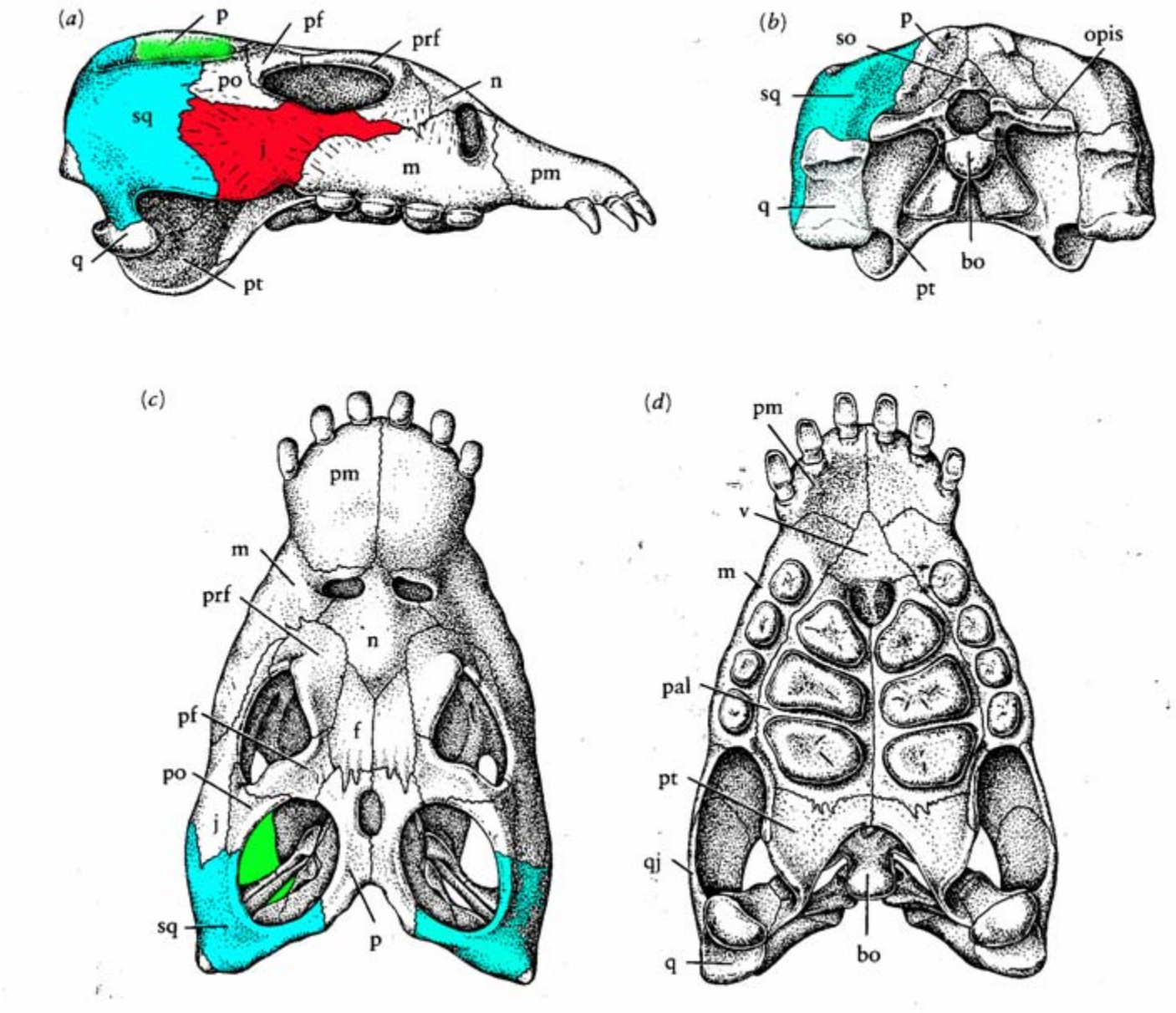
Placodonts were fusiform but large animals that lived in the Middle to Upper Triassic.

Similar to manatees in the niche they filled.



*Placodus gigas* (type)

Large teeth and palatal teeth indicate that it probably ate molluscs.




*Placodus gigas*

*Paraplacodus*

Diapsida

Sauropterygia

Placodontia

Nothosauria

Pleisosauria

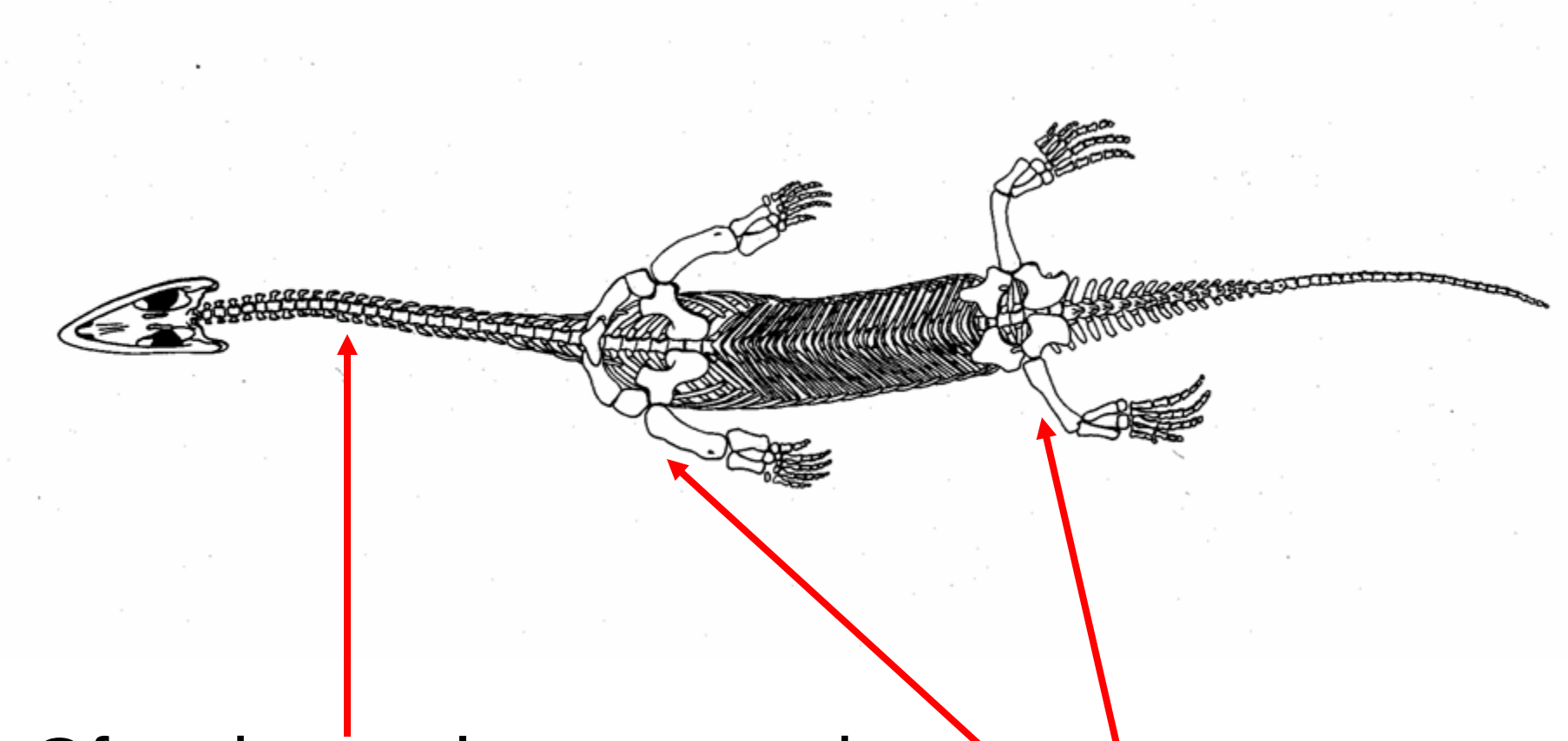
Ichthyosauria

Squamata

Mosasauria

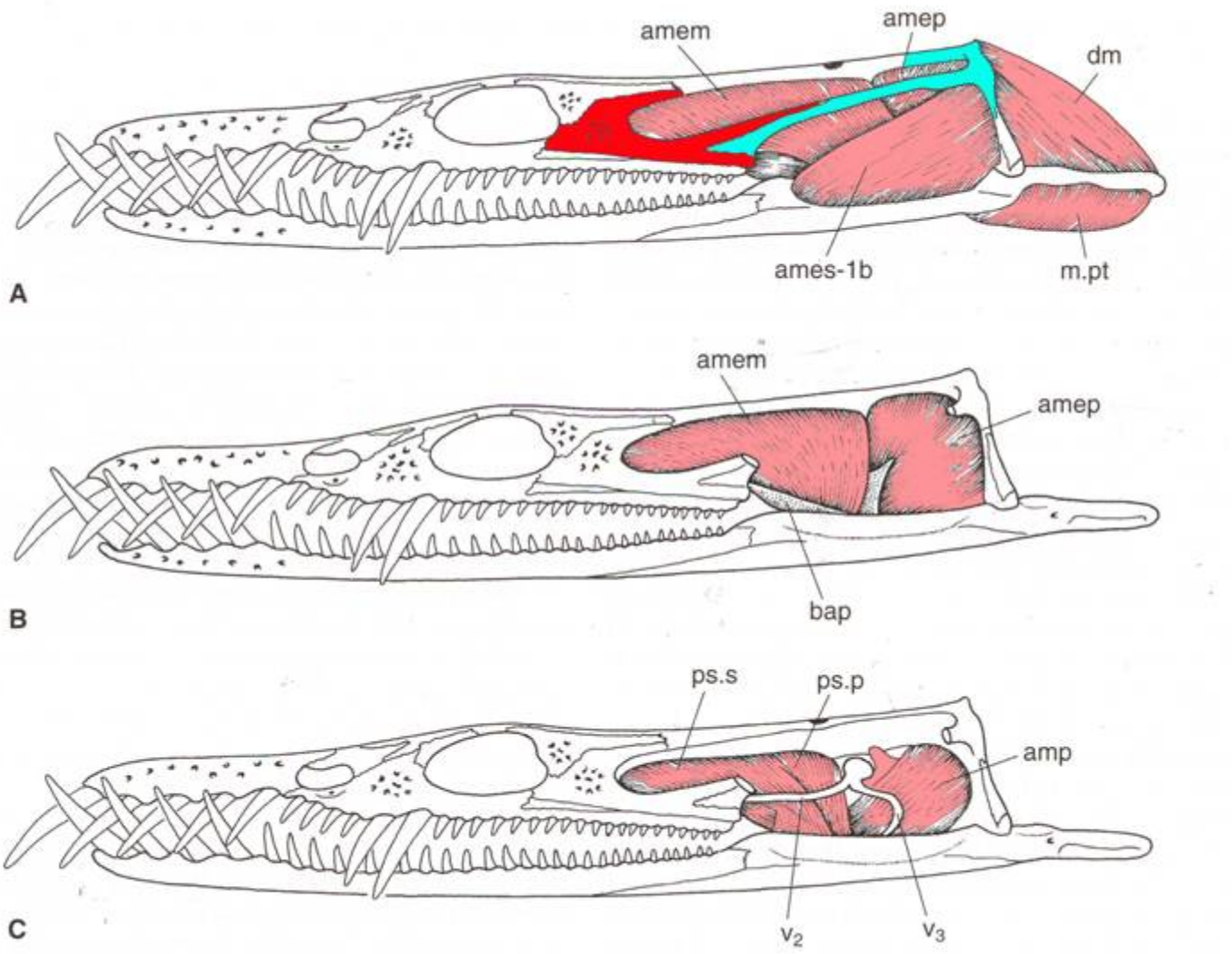
Nothosauria:

- Middle to Upper Triassic
- Very short snout end of skull, relatively longer caudal (postorbital) region of skull.
- Large, procumbent rostral (frontmost) teeth, often developed as fangs.



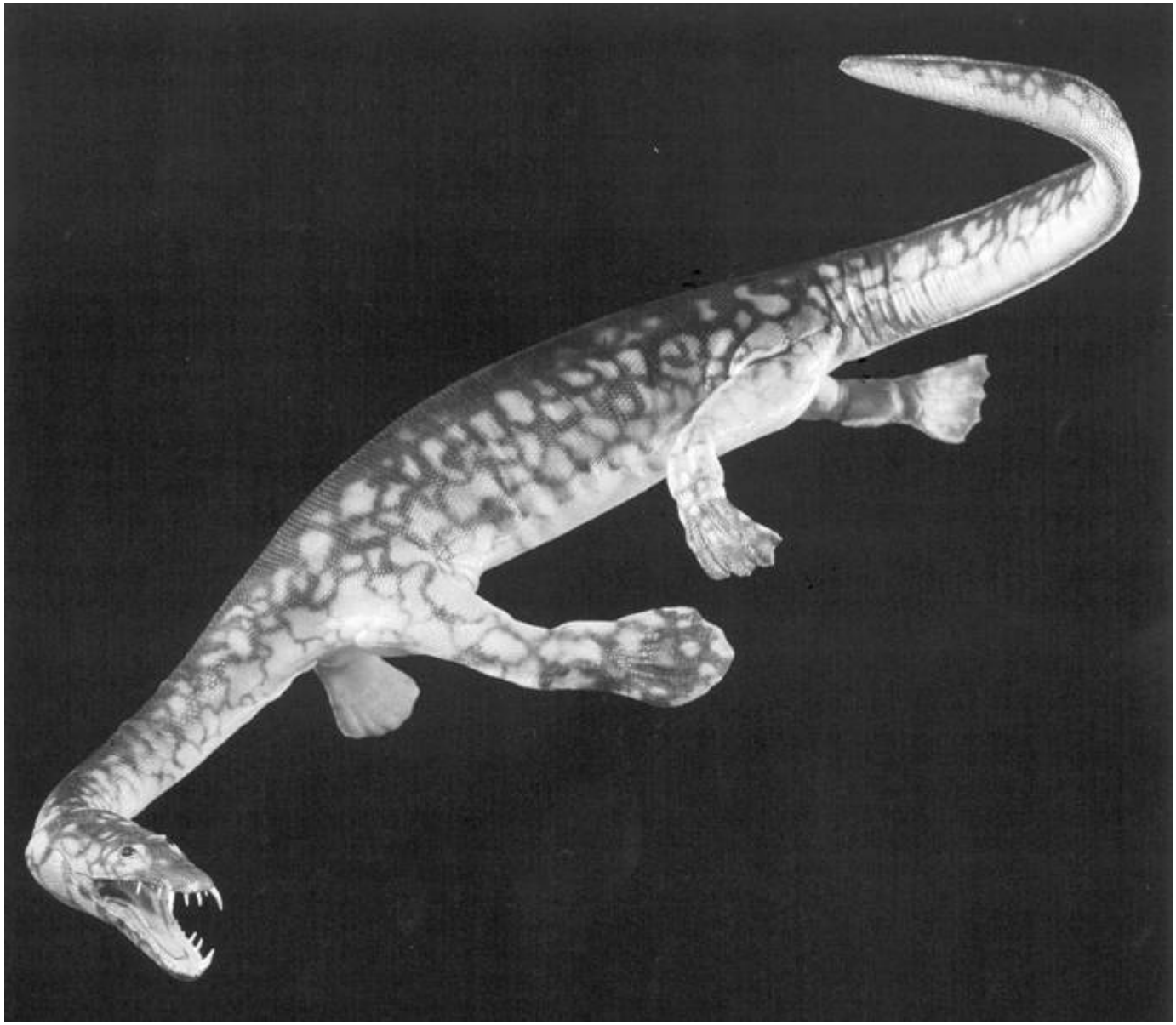
Often have elongate necks.

Humerus and femur longer than more distal elements.




*Nothosaurus mirabilus*

Reconstruction of skull and jaw musculature



*Nothosaurus*:  reconstruction

Diapsida

Sauropterygia

Placodontia

Nothosauria

Pleisosauria

Ichthyosauria

Squamata

Mosasauria

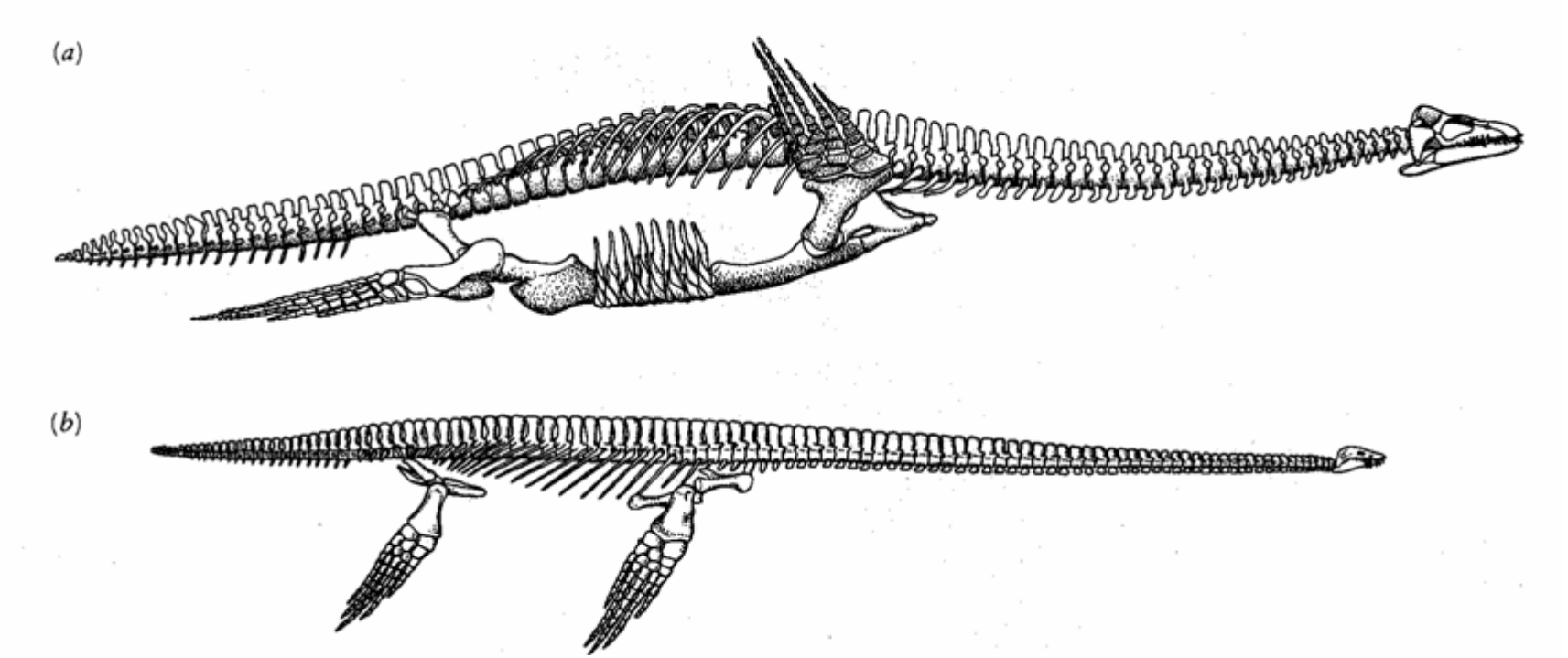
Plesiosauria:

- Much larger than nothosaurs.
- Forelimbs and hindlimbs look much more similar.
- EXTREMELY elongate necks, even more so than nothosaurs.
- Note that despite paddle-like nature of hand (manus) and foot (pes), each still retains only five digits.

Plesiosaurs have

HYPERPHALANGY: additional segments to the digits of the fingers and toes.

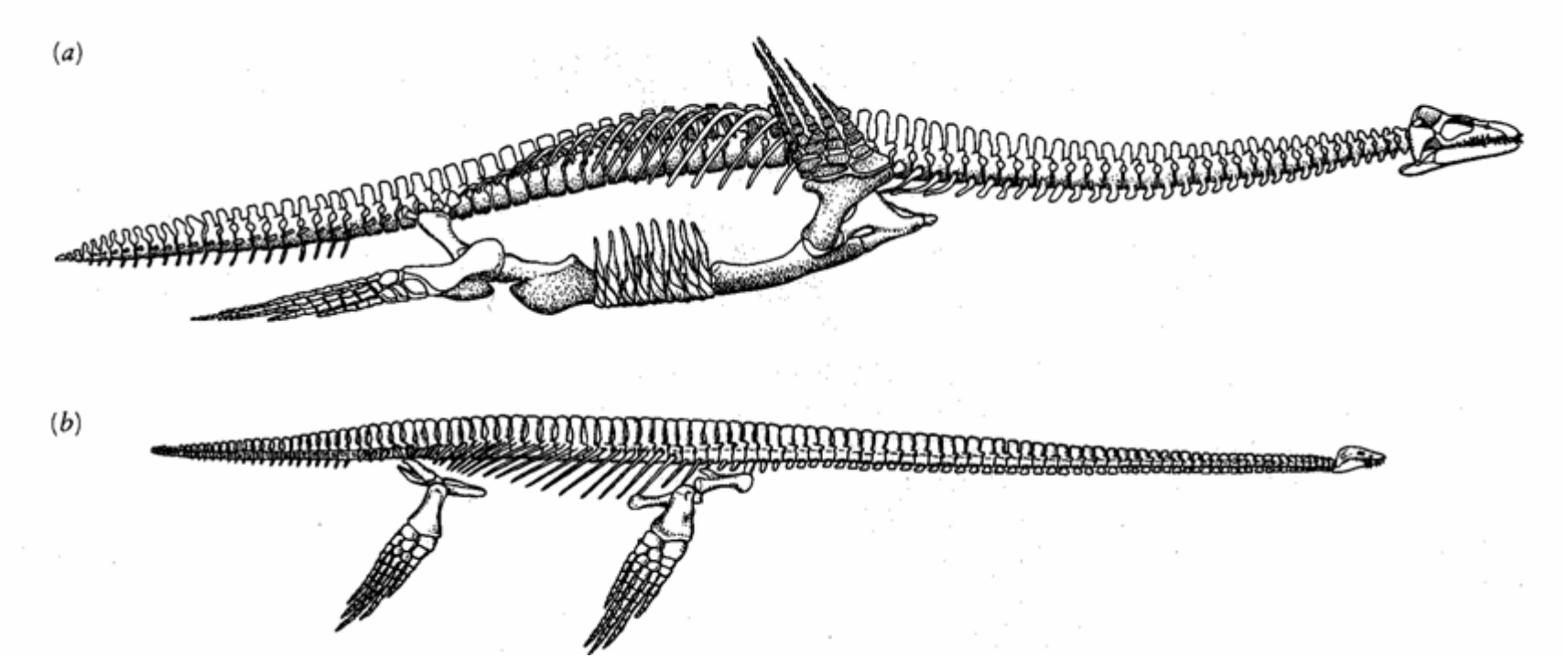
# *Cryptoclidus* (plesiosaurid)




Plesiosaurs have HYPERPHALANGY: additional segments to the digits of the fingers and toes.

*Hydrothecrosaurus* (elasmosaurid)

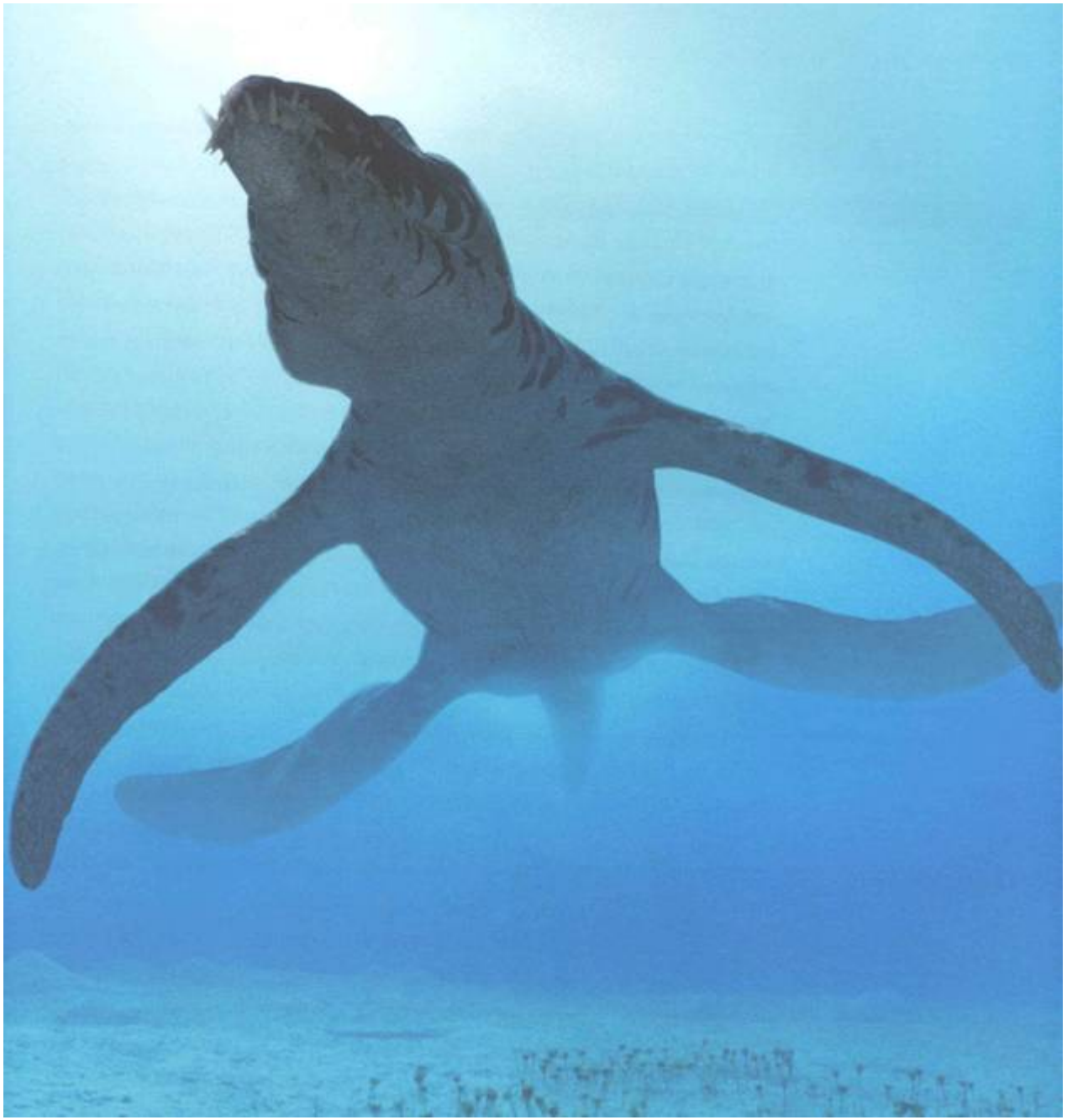
# *Cryptoclidus* (plesiosaurid)




*Hydrothecrosaurus*
(elasmosaurid)

*Cryptocleidus*

(about 30 meters long)



*Liopleurodon*

(about 80 feet long)

Diapsida

Sauropterygia

Placodontia

Nothosauria

Pleisosauria

Ichthyosauria

Squamata

Mosasauria

# Ichthyosauria

- Triassic to Cretaceous – However, more extreme members of group lived in Jurassic and Cretaceous.

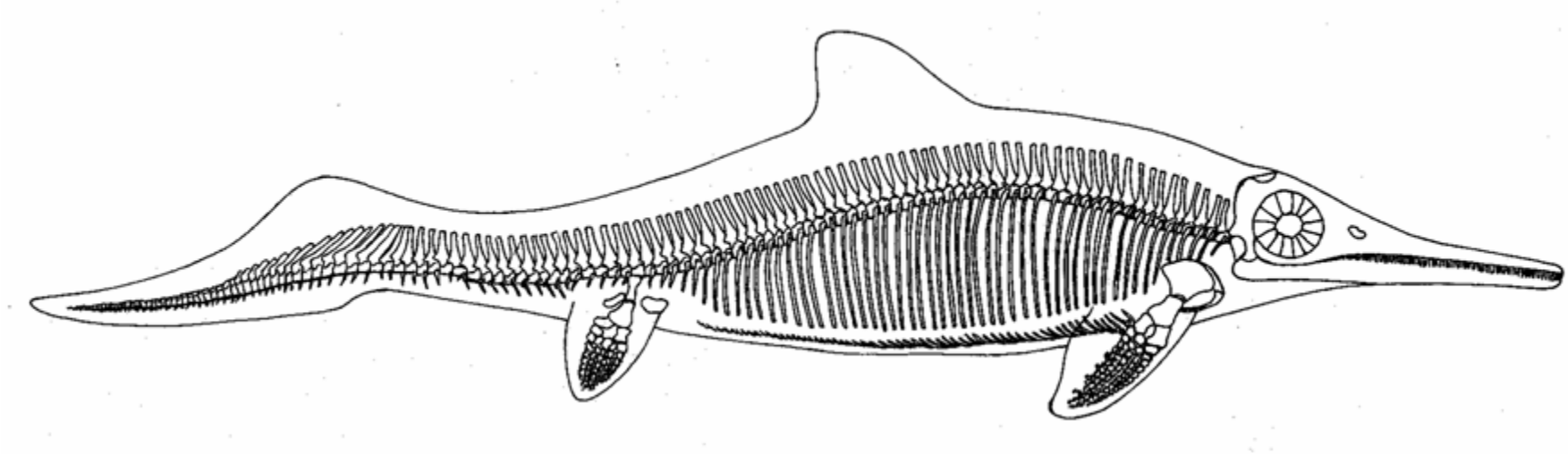
- Most highly specialized of marine reptiles. They converged on fish and cetacean forms.

- Highly modified skull: large orbit, reduced cheek region, elongate snout.

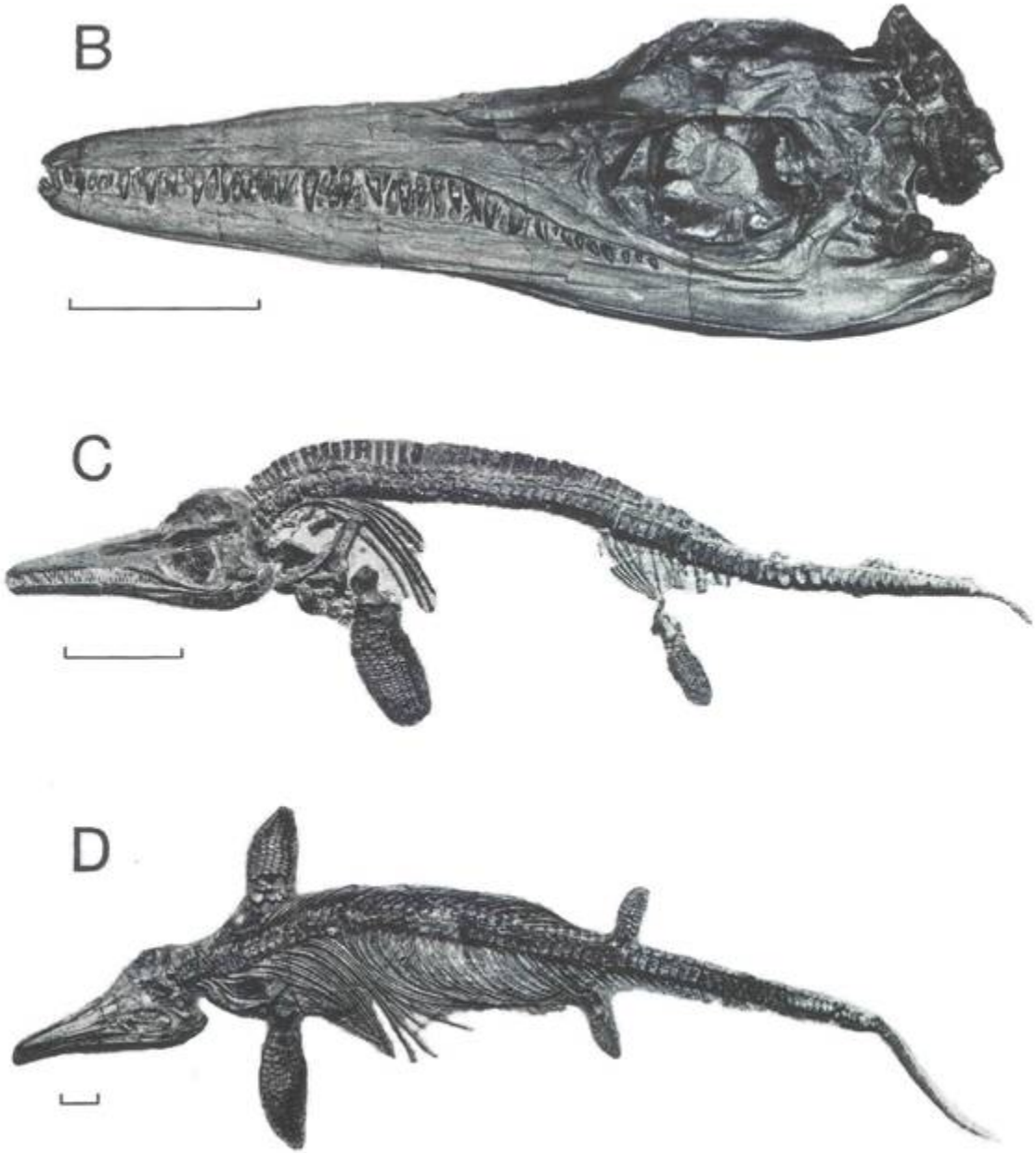
- Limbs modified into flippers; hyperdactyly.

- Viviperous: gave birth to live young.

*Mixosaurus* reconstruction



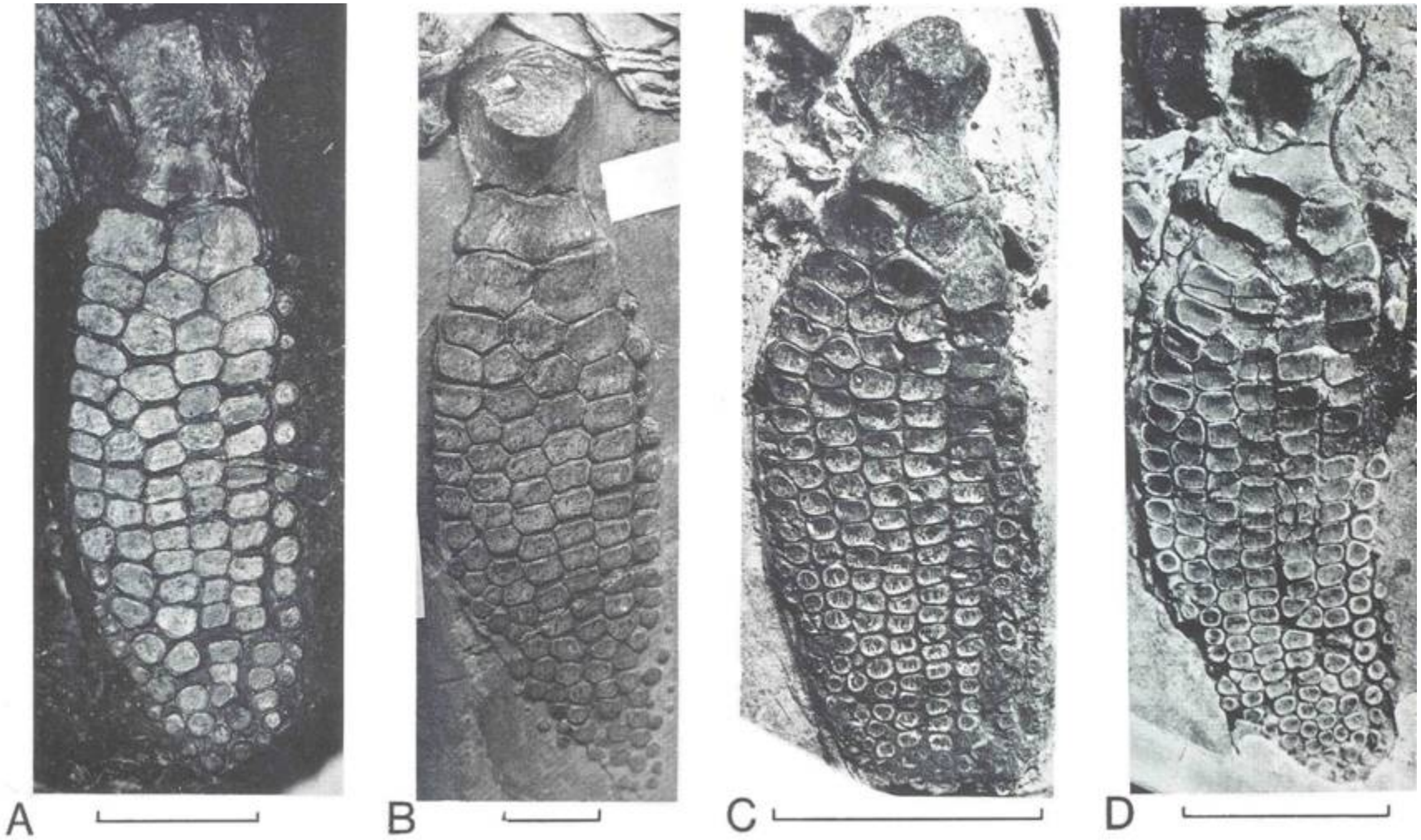
Most highly specialized of marine reptiles.  They converged on fish and cetacean forms.



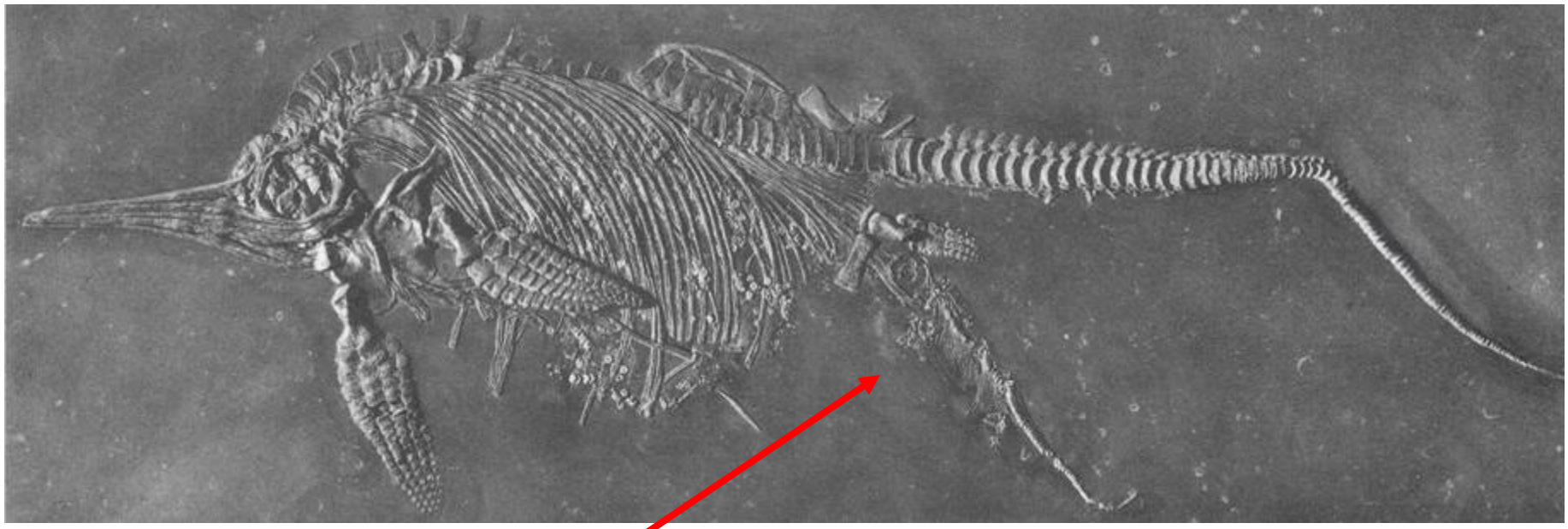

Highly modified skull: large orbit, reduced cheek region, elongate snout.

Most highly specialized of marine reptiles. They converged on fish and cetacean forms.

*Ichthyosaurus*




Limbs modified into flippers; hyperdactyly and hyperphalyngy.



Juvenile at moment of birth.

Juvenile *Ophthalmosaurus*

Diapsida

Sauropterygia

Placodontia

Nothosauria

Pleisosauria

Ichthyosauria

Squamata

Mosasauria

Mosasaurs:

- Not closely related to Sauropterygians or Ichthyosaurs.

- Actually highly derived members of the lizard family Varanidae.

- Late Cretaceous ecological replacements for Ichthyosauria.

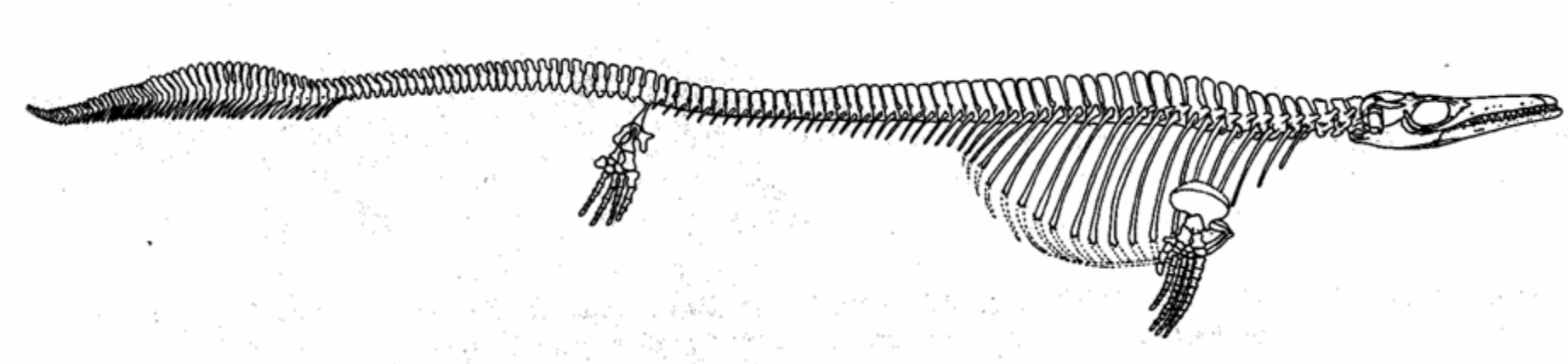
Mosasaur Anatomy:

•Extremely elongate tail, body narrower and slimmer than other groups surveyed. (Probably swam in a more eel-like fashion.)

•However, neck, remains relatively short.

•Limbs modified for steering as opposed to propulsion.

•Have HYPER PHALANGY, but not hyerdactyly.



*Plotosaurus*, a mosasaur over 10 meters in length.